ACRP

REPORT 57

AIRPORT COOPERATIVE RESEARCH PROGRAM

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The Carbon Market: A Primer for Airports

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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 57

The Carbon Market: A Primer for Airports

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), and the Air Transport Association (ATA) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

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Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

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FOREWORD

By Joseph D. Navarrete
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ACRP Report 57: The Carbon Market: A Primer for Airports provides the airport community with current, relevant information on carbon and other environmental credit trading markets, potential opportunities, and challenges to airport participation in these markets. Carbon and other environmental markets are dynamic and present new terms and concepts. The *Primer* will therefore be of interest to anyone desiring a basic understanding of current markets in the context of airports, including their structure, driving forces, sponsor obligations, and the impacts of current policies.

The growing concern for the impact of CO_2 emissions on the environment has led to policies and regulations designed to control and limit greenhouse gas emissions. One outcome of these regulations has been the development of carbon markets, where carbon credits are bought, sold, and traded as a market-based approach to control emissions. Airports are now exploring whether there may be revenue opportunities generated by selling credits in the carbon market. However, as the carbon credit market is complex and continually evolving, decision makers are faced with many questions regarding airport participation, including the kind of credits airports can create or trade, who can take credit for various actions at an airport, the minimum level of credits needed to be marketable, and how carbon trading would affect airport compliance obligations, including grant assurances made to the federal government.

The research, led by Pace Global Energy Services, shows that, while airports can potentially gain monetary or reputational value by hosting carbon offset and renewable energy projects, the opportunities for airports are limited for several reasons. First, the lack of a federally mandated, comprehensive carbon trading scheme limits demand for overall credits. Second, the kinds of projects that can be practically implemented at airports are not often conducive to selling the credit associated with the activity. Finally, there are regulatory factors that limit the types of projects that can be implemented on airport property. The *Primer* also examines the potential opportunities of renewable energy credits for airports, which are also a tradable instrument.

The *Primer* is organized into six chapters. Chapter 1 provides an introduction and background to greenhouse gases, carbon markets and instruments, carbon projects at airports, and unique issues airports may face. Chapter 2 evaluates typical airport projects relative to their marketability in carbon markets. An overview of North American compliance carbon markets is provided in Chapter 3. Chapter 4 provides an overview of the global carbon market, while Chapter 5 describes renewable energy and associated markets. Finally, Chapter 6 outlines how offset credits and renewable energy certificates are traded and the implication of retiring credits. Throughout the document, the reader will find relevant case study examples drawn from several airports. The *Primer* also includes a list of abbreviations and acronyms as well as a glossary.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

SUMMARY

The Carbon Market: A Primer for Airports

Introduction

The objective of ACRP Project 11-02 (Task 18), "Primer on Carbon Credits and Revenue Opportunities for Airports" is to prepare a primer for airport owners, managers, and operators that describes the evolving "carbon markets" and identifies revenue opportunities for airports in the United States. To date, there have been limited examples of airports generating additional revenue from carbon markets. There are a variety of reasons for the lack of participation to date. First, carbon, renewable energy, and other related environmental markets are relatively new in the United States and generally lack a federal regulatory system to drive significant demand for many potential revenue opportunities. Second, airports have unique limitations, both in terms of airport operating rules and land holdings, which prevent certain project types from taking place on airport grounds.

Despite these restrictions, certain project types related to these markets align well with airports. There are many examples of airports investing in projects and practices that lower their carbon footprints and improve the environment. There are increasing examples of airports installing solar panels and using other forms of renewable energy. Exploring ways to use energy more efficiently is common practice amongst airport managers and a proven way to lower carbon footprints. However, as this *Primer* will discuss, not all activities that lower an airport's carbon footprint will result in an opportunity to generate additional revenues in these markets.

The concepts and mechanisms that make up carbon and other environmental markets are unique. Terms like "cap-and-trade" and "carbon credit" are becoming more common in our vernacular; however, there is often a lack of understanding behind the key principles associated with these and related terms. This *Primer* is intended to provide some guidance and background to the airport community of some of the concepts and terms that apply to carbon markets. Particularly given the dynamic nature of carbon markets, a core understanding of certain principles is critical to airport owners that may be seeking opportunities for additional revenue in carbon markets in the future.

Currently, most airports in the Unites States are not directly required by law to reduce their GHG emissions, nor are they expected to in the immediate future. In fact, with only a few states implementing regional carbon cap-and-trade programs, there are very few regulations requiring substantial GHG reductions for *any* type of entity. Therefore, outside of a handful of airports in the past that have been required to reduce or monitor emissions as a prerequisite for a building permit or pursuant to a city ordinance, most of the potential airport participation discussed herein relates to hosting voluntary projects and evaluating the potential to sell the associated carbon credits in what is commonly referred to as the *voluntary carbon market.*

Findings

There are two primary sources of value that can be created for airport operators that host carbon offset and renewable energy projects. The first is monetary. Developers of projects can sell the environmental benefits of their projects in the form of offset credits or renewable energy credits (RECs). By selling these credits, however, the airport operator in essence gives away the right to claim their own emission reduction or renewable electricity generation in turn for a defined revenue stream. The second is reputational value and good environmental stewardship. In order to be fully recognized for the environmental benefits of a project, an airport sponsor would need to retire, which is to say remove from circulation, the credit to ensure no other person can claim the environmental benefits of the project. The act of retiring a credit effectively locks in the link of the environmental attributes to the person or entity that elected to retire the credit. The weighing of these two benefits—monetary vs. reputational and stewardship—is critical for airport operators to understand as they consider projects.

Revenue opportunities for United States airports in carbon and renewable markets are limited at this time by a number of factors. First, the lack of comprehensive national regulatory requirements in the United States for GHG emission reduction or renewable generation mandates has resulted in limited demand and overall weak pricing for credits domestically.

Second, there are limited activities or projects on airport grounds that can feasibly be implemented by airports that will lead to sufficient credits and revenue to justify project sponsorship. Airports sponsors engage in many projects that reduce airport-related emissions. While these projects often have a positive impact on the environment and lower an airport's carbon footprint, in many instances the activity is not conducive to selling the credit associated with the activity.

Third, safety and other regulatory restrictions limit the types of projects that can be implemented on airport grounds.

While there are numerous examples of airports installing renewable energy systems, to date, no United States–based airports have hosted an on-site GHG reduction project for which carbon offset credits were generated and later sold. The types of activities that airports typically engage in do not align with many of the formally recognized offset program types. Further, offset project types that could be hosted at airports would generate relatively few offset credits and limited future revenue to economically drive the project based solely on the additional revenue from offset credits.

In a case study performed for this *Primer* at the Austin Bergstrom International Airport in Austin, Texas, the research team considered an organic waste composting project whereby organic waste usually sent to landfills would be separated and composted in an organic waste composting system to generate offset credits. The project would result in minimal offset credits, netting an estimated $699 a year. Revenue at this level would likely not be substantial enough to justify the costs of the project, particularly if increased revenues were the sole motivation for hosting a project.

The research team examined a pending reforestation project at the Montreal-Mirabel International Airport in Mirabel, Canada. The airport has partnered with a carbon offset project developer to plant approximately 96,000 tree saplings in between access roads which connect the airport terminal building to the local highway. In total, it is estimated that the project will generate 16,382 offset credits and has the potential to net the project developer hundreds of thousands of dollars over the lifetime of the project.

In addition to examining opportunities for airports to host projects that generate offset credits, the *Primer* also examines the possibility of generating RECs—a different type of environmental credit—from renewable energy projects sponsored by airports. While offset credits refer to tradable instruments directly associated with GHG reduction projects, RECs represent another tradable environmental instrument that may present revenue opportunities for airports. The definition of RECs varies slightly program to program but generally represents the environmental attributes of renewable electricity generation, including its low or zero carbon emissions. Thus, in the United States, renewable energy generally would not qualify to generate offset credits.

The installation of solar panels at airports has been the most common form of renewable energy project, although airports to date have generally not sold the RECs associated with the renewable generation. In select states, hosting solar generation projects has the potential to generate the greatest amount of revenue in either the carbon or REC markets.

In a case study performed at the Meadows Field Airport in Bakersfield, California, the airport entered into a contract with a solar service provider to install a 744 kW solar energy system on site. As part of the arrangement, the county of Kern, the owner and operator of the airport, retained the rights to half of the RECs generated from the project. In this example, the county retains about 1,600 RECs per year. The value of RECs varies greatly based on where a project is located, and due to the nature of the California REC market, RECs from the Bakersfield project may be worth only a few dollars apiece—although policy changes may soon increase those values. However, a similarly situated project located in select Mid-Atlantic and Northeastern states could be worth several hundred dollars per REC due to policies in place, resulting in revenues of several hundreds of thousands of dollars. Revenues from selling RECs from solar generation will likely be diminished to some degree by the substantially higher cost of installing solar panels over other more traditional forms of energy.

Conclusions and Recommendations

Airport operators interested in participating in carbon and other related environmental markets must determine at the outset their motivations. If they are motivated by environmental stewardship and the associated reputational benefits, there exist opportunities for airports to increase efficiency, reduce GHGs, and generate renewable power. Replacing old and inefficient equipment, improving insulation, and other measures that allow energy to be used more efficiently should all be considered as ways to demonstrate a commitment to the environment and to decrease an airport's carbon footprint. Other measures, such as planting trees along access roads (or other locations that do not interfere with or violate aviation regulations) and composting organic waste can have incremental GHG impacts, but when viewed with other actions can help boost an airport's environmental reputation.

Significant revenue opportunities for airports to generate carbon credits and sell into markets for a revenue stream have yet to materialize in the United States as no comprehensive, mandatory carbon trading scheme exists to drive a robust price on carbon credits. The carbon offset project types that are traditionally recognized to produce salable carbon offset credits in the United States do not align well with airport infrastructure or can be challenging to implement due to airport safety regulations. These project types include managing organic waste and planting trees onsite. While these are viable offset projects available to airports, the number of offset credits that can be generated from such projects is likely to be limited. Relative to other installations and institutions, airports have low on-site emissions limiting the number of offset credits that can be earned for reducing emissions. Equally,

airports have limitations on landholdings, reducing opportunities for generating offset credits from changes in land use.

Improving energy efficiency may have the greatest impact on an airport's carbon footprint while also providing energy cost savings; however, revenue opportunities from selling offset credits may be even more limited than other offset project types due to the current state of domestic offset standards. Some offset standards bodies do not recognize energy efficiency as an eligible project type limiting demand in the voluntary market.

More potential revenue opportunities exist in renewable energy markets through the sale of RECs from onsite renewable generation projects. The value of these RECs is largely determined based on what renewable technology is being implemented and where the project is located. Airport operators should work closely with market experts to ensure that they are monetizing the RECs appropriately and guarantee the revenue through a binding contract vehicle.

An airport operator motivated by potential increased revenue streams may find fewer opportunities, most of which do not outweigh the diminished ability to claim environmental benefits. The current lack of comprehensive federally regulated carbon markets in the United States, along with other airport specific restrictions, limits revenue opportunities from hosting offset and renewable energy projects and selling the associated credits.

At this time, and in most cases, there is more value to airports in reputational benefits from GHG reductions and renewable generation than there is from additional revenue streams. For this reason, the following actions are recommended to airport operators:

- Identify the motivation behind participating in carbon and environmental markets and weigh the balance between the cost-benefits and environmental reputational benefits.
- Develop a robust GHG inventory to track GHG emissions. Inventories allow airports to measure GHG reductions from various activities and share improvements with the public. Further, in the event that an airport operator elects to sponsor an offset project, measured baseline emissions are often a prerequisite. Having an existing GHG inventory, particularly if it is developed through one of the leading GHG inventory organizations, can help expedite the offset project registration process in the future.
- Identify emission reduction activities at the airport and see if they align with major offset standard bodies' offset protocols. Projects most likely to be available to airports are managing organic waste and planting trees onsite.
- Consider installing renewable power systems. Solar and other renewable power systems in states that have regulations requiring certain levels of solar installations or small power systems will have the greatest revenue opportunities to airports.

CHAPTER 1

Introduction and Background

This *Primer* is intended to:

1. Provide a comprehensive overview of the evolving greenhouse gas (GHG) credit or carbon credit and related markets.
2. Describe the role airports play in these markets.
3. Identify areas where U.S. airports may be able to participate and capture additional revenue or other forms of reputational or environmental stewardship value from these markets.

In this arena, and for the purposes of the *Primer*, the term "carbon" is used interchangeably with GHG. Carbon value generation can come in many forms—new and enhanced revenue streams, as well as risk (regulatory and reputational) reduction and avoidance. Airport sponsors of certain project types have the potential to realize additional revenues and capture other forms of value.

Four case studies were prepared as part of this *Primer*. To date, few airports have sought additional revenue streams from carbon reducing projects and investments. The case studies examine actual projects implemented at airports and explore how airports might seek additional revenue from various carbon reducing activities.

The principal focus of the *Primer* is identifying value generating opportunities for airports offered by carbon markets. However, in order for airports to identify areas of potential value, a general understanding of carbon markets and their instruments is required. The *Primer* is organized to provide the user background on carbon markets, carbon instruments, and the current state of carbon markets for context and is followed by content to inform airport participants how to ultimately implement carbon related initiatives.

Scientific data suggest that anthropogenic or human-caused GHG emissions are increasing the Earth's temperature and altering atmospheric patterns. The Intergovernmental Panel on Climate Change (IPCC) concluded in its Fourth Assessment Report that "Most of the observed increase in global temperatures since the mid-20th century is very likely due to observed increase in anthropogenic GHG concentrations" (Solomon 2007). This is placing significant pressure on governments, businesses, and individuals to reduce GHG emissions. Reducing carbon emissions has the potential to come at great cost. Market-based programs are popular policy frameworks that provide a flexible means to reduce GHG emissions and meet overall reduction targets while minimizing the overall cost. "Cap-and-trade" programs are a common market-based program employed to reduce emissions.

1.1 Overview of GHGs

Key Takeaways for Airports

- GHGs are compounds that retain heat and at elevated levels have been linked to warming the Earth's temperature.
- Airport sponsors can control and influence the release of GHGs from a variety of sources and activities undertaken onsite, but the majority of GHG emissions at airports are tenant-controlled.
- Airport sponsors may be eligible to "earn" offset credits by reducing GHG emissions.

GHGs are gases that collect in the atmosphere, absorbing and re-emitting solar radiation through a process commonly referred to as the greenhouse gas effect. With greater concentrations of GHGs in the atmosphere, heat is trapped and contributes to an increase in global temperatures. Some GHGs occur naturally and collect in the atmosphere through natural processes. Other anthropogenic GHGs are created and emitted through human activities.

Generally, when people refer to GHGs in the context of the carbon markets, they are referring to the six GHGs emitted through human activity and covered by the Kyoto Protocol. The six Kyoto GHGs include: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); sulfur hexafluoride (SF_6); hydrofluorocarbons (HFCs); and perfluorocarbons (PFCs). The Kyoto GHGs have varying levels of contribution to global warming. In order to account for the impacts each GHG has on global warming, a commonly used scale has been developed to measure the global warming potential (GWP) of each GHG. GWP uses a relative scale which measures each GHG to that of the same mass of carbon dioxide. Often GHGs will be expressed in terms of their carbon dioxide equivalent (CO_2e), based on that GHG's GWP (UNFCCC n.d.). For example, 1 tonne of methane emissions, with a GWP of 21, would have a CO_2e of 21 tonnes. Equally, 1 tonne of CO_2 emissions, with a GWP of 1, would have a CO_2e of only 1 tonne. Table 1 presents the global warming potentials of the six Kyoto GHGs.

Each of these GHGs is created and emitted in a different manner and through different mediums or actions. CO_2 enters the atmosphere through the burning of fossil fuels, trees and wood products, solid waste, and as a result of chemical reactions. It is sequestered through part of the

Table 1. Greenhouse gas global warming potentials.

Greenhouse Gas	GWP or CO_2e
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
Sulfur hexafluoride (SF_6)	23,900
Hydrofluorocarbons (HFCs)	Varies by specific HFC (140 – 11,700)
Perfluorocarbons (PFCs)	Varies by specific PFC (6,500 – 9,200)

Source: IPCC. *Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change 2007*. Cambridge, United Kingdom: Cambridge University Press, 2007.

biological carbon cycle, when it is absorbed by plants. CH_4 is generally emitted through the production and transport of coal, oil, and natural gas. Emissions can also be the result of decay or organic waste in landfills or agricultural processes. N_2O is produced by both natural and human-related sources. Trace amounts of both CH_4 and N_2O are released from the combustion of fossil fuels. Soil management, animal manure, sewage treatment, and combustion of some fuels are examples of manmade sources of N_2O. HFCs, PFCs, and SF_6, known collectively as fluorinated gases, have relatively high GWP and are emitted from a variety of different industrial processes. They are occasionally used as substitutes for ozone-depleting substances (ODS), which the international community has been phasing out for the last few decades.

GHG emissions from airports are primarily from combustion sources as presented in Table 2. Note that sources that are directly linked to tenants, i.e. airplane emissions and electricity consumed from tenant space, are generally attributed to tenants and not the airport itself.

Globally and in the United States, GHG emissions have increased over the past few decades. In the United States alone, GHG emissions increased by 17% between 1990 and 2007 (EPA, Climate Change n.d.). With the large expansion of industrial production to meet the world's growing population, along with increasing quality of life in many developing countries, GHG emissions are expected to continue to rise in the future. With the recent global focus on the impacts and effects of GHGs, many countries have made focused efforts to improve efficiency and promote clean technologies, as well as to educate the public on the impact their daily choices have on the amount of GHGs being emitted.

Table 2. Airport GHG emission sources.

Source	GHG Emission(s)	Examples
Fossil fuel combustion	Primarily CO_2 Trace volumes of CH_4 and N_2O	Aircraft—idle, takeoff, in flight, landing, auxiliary power units Vehicles—ground support equipment, maintenance, baggage tractors, shuttle buses, private and public vehicles Stationary equipment—generators, heaters, belt movers Other miscellaneous—construction equipment, flares, fires, etc.
Refrigerants	HFCs	Fugitive refrigeration from vehicles and building HVAC systems
Waste decomposition	CH_4	Organic matter decomposition (i.e., food, plant wastes) Wastewater management
Electricity consumption	Primarily CO_2 Trace volumes of CH_4 and N_2O	Purchased electricity from coal, natural gas and/or petroleum products Onsite electric production from coal, natural gas and/or petroleum products

Source: Kim, Brian. *Guidebook on Preparing Airport Greenhouse Gas (GHG) Emissions Inventories*. Palm Springs, CA: UC Symposium on Aviation Noise and Air Quality, 2009.

1.2 Overview of Carbon Markets and Instruments

Key Takeaways for Airports

- The United States does not have a mandatory cap-and-trade program in place and under most legislative proposals in the past, airports have not been targeted entities that would be required to reduce or account for their GHG emissions.
- Other regulated entities, like electricity providers, would be expected to pass the cost of carbon compliance onto consumers downstream, such as airports.
- Engaging in activities that reduce, avoid, or sequester emissions may present an opportunity to "earn" carbon offset credits, which are tradable commodities that represent GHG reductions.
- Demand for carbon offset credits exists in both the voluntary and mandatory carbon markets.

At the outset, there are a few concepts and terms that should be understood. A carbon credit is a term that is often used to describe, correctly and incorrectly, a wide variety of tradable environmental instruments (i.e., a representation of some action or inaction that has environmental consequences). For the purposes of this *Primer,* more specific terms will be used depending on the instrument of reference. Generally, a carbon credit refers to a tradable certificate representing one tonne of CO_2e and is classified as either an "allowance" or an "offset." Figure 1 summarizes the specific types of carbon instruments and their applicability in different markets.

"Allowances" are usually created as the result of a cap-and-trade system. Under a cap-and-trade system, a mandatory limit on GHG emissions is set by a governing body. Regulated entities within that system must surrender allowances equivalent to the amount that they emit and are permitted to find least cost ways to meet the limit. These regulated entities are sometimes referred to as "points of regulation." Generally, the mandatory limit, referred to as "the cap," is set by the governmental body and applies to a certain sector or group of sectors in the economy. Tradable emission allowances are distributed by the government in an amount equal to the total emissions permitted by the cap. Generally, the cap, or the number of allowances distributed, declines over time, thus ensuring reductions of total GHG emissions by the covered sectors collectively. Traditionally, airports and other transportation ports have not been targeted as sectors covered under the mandates. However, airports and other end users of fuels and electricity may be indi-

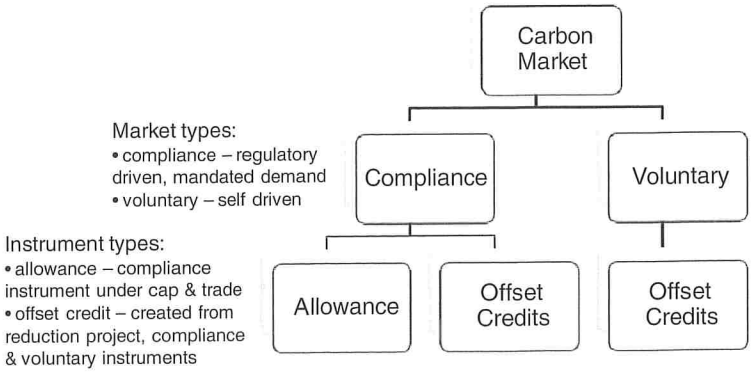


Figure 1. Carbon markets and instruments.

rectly impacted by a cap-and-trade scheme when regulated power and fuel producers pass the costs of GHG regulation on to end users.

Allowances can be traded (bought or sold) among other market participants. With a limited number of allowances available in the system to cover the emissions from regulated entities and facilities, allowances become a demanded commodity. If the price of allowances is driven high enough, regulated entities and facilities will find that investing in and implementing new, low emitting technologies and operational practices will be a lower cost alternative to procuring allowances in the marketplace. When the cost of reducing emissions is high and allowance prices are low, the preferred economic option for compliance will be to purchase allowances more and reduce emissions less. Conversely, when the costs of allowance prices are high and the cost of reducing emissions is low, the impetus will be to adjust emitting activities before purchasing costly allowances.

An "offset" credit represents a tonne of CO_2e; however, unlike an allowance, an offset credit represents a tonne that is avoided, captured, or sequestered from a source that is not required by law to reduce emissions, and can be used to compensate for emissions made elsewhere. Often cap-and-trade system rules permit the regulated entities to procure offset credits and use them toward their compliance requirements as an added flexible means to comply. The number of offset credits used for compliance by an entity or facility is often limited by a total number of offset credits or by a percentage of that entity's total emissions during a compliance year. Unlike allowances, offset credits can also have monetary value outside of regulatory or compliance cap-and-trade systems as created by non-regulated carbon markets, called the voluntary market.

In the voluntary market, there are companies, governments, and individuals that may wish to purchase and retire offset credits in order to "offset" or reduce a particular GHG emitting activity attributed to them. As will be discussed later in the *Primer*, retiring offset credits—taking them out of circulation—locks in the environmental benefits associated with the GHG offsetting activity to whoever is retiring the offset credit. A common example in the transportation sector is a passenger who pays incrementally to offset the emissions resulting from the air travel in order to claim the trip as "carbon neutral." While the flight in this example still emits GHGs from the combustion of jet fuel, the passenger can claim carbon neutrality for his or her own journey as the result of a reduction in GHGs made elsewhere. An overview of carbon market instruments is presented in Figure 1.

Offset credits are generated from offset projects and include a wide variety of activities and installations that are generally governed by strict protocols. Whether an offset credit originating from one of these projects has any value largely depends on whether there is either a regulatory program or a voluntary offset standard that recognizes that particular project type. Section 2.1, Offset Credit Origination, will provide a description of typically recognized offset project types in the United States and explore opportunities for airports to potentially engage.

1.3 Carbon Projects at Airports

Airport sponsors are increasingly taking action to reduce their carbon footprint, motivated by potential future regulations, local requirements, and good environmental stewardship. Numerous states have already taken action to address GHG emissions, with some mandating specific reduction targets. Such actions—along with the possibility of federal legislation—are likely to result in downstream costs (increased electricity and fuel costs) for airport sponsors.

Early preparation and planning for GHG emission reductions can reduce regulatory risks and provide insight into the fiscal impacts of achieving GHG reductions. Hence, one challenge airport

sponsors face is the identification and prioritization of projects that should be accelerated based on their energy and GHG benefits. To this point, many airport sponsors that have tackled GHG emissions have been rewarded with reduced operating costs through avoided energy consumption. Very few airport sponsors have capitalized further by seeking potential revenue streams from facilitating offset projects at airport facilities. There are multiple reasons for this, including the following:

- Many of the activities and investments that airports engage in that reduce carbon emissions, such as improving energy efficiency, are not typically the type for which salable offset credits will be created.
- Carbon markets in the United States have been slow to develop, and identifying projects that would provide additional revenue can be challenging.
- Airport revenues are regulated, and this could potentially limit some opportunities for offset credit monetization. Specifically, airport sponsors are required to use airport revenue only for "the capital and operating costs of the airport, the local airport system, or other local facilities owned or operated by the airport sponsor and which are directly and substantially related to the air transportation of passengers or property." This is something that would need further interpretation by the FAA on a case-by-case basis.
- Airport safety issues and regulations can impact applicability of certain carbon reduction projects at or near airport properties.
- Finally, because these markets are new, evolving, and complex, there is a lack of awareness of the market potential by airport sponsors.

To date there have been limited examples of airports hosting projects that have been credited with tradable offset credits. However, there are examples of airport projects which could be eligible to earn other forms of environmental credits—like renewable energy certificates (RECs) from renewable energy projects and airport emission reduction credits. These instruments will be explained later in the *Primer*. Table 3 is a review of some past airport projects and the type of environmental instrument likely to be associated with that project.

1.4 Airport Constraints as Related to Carbon Credits and Other Revenue Opportunities

Key Takeaways for Airports

- Restrictions on the use of airport revenue, including federal law and grant assurances, must be considered when assessing the feasibility of a carbon project.
- Land use restrictions at airports have the potential to impact the viability of certain offset projects that may encumber air or land space.

This *Primer* will address a variety of project types that could potentially be implemented at airports in order to generate offset credits or other tradable environmental credits. Airports are unique entities with certain constraints on how capital can be spent in order to pursue revenue opportunities. These constraints should be considered at the outset by airports when considering a potential carbon, renewable, or other project type.

At the federal level, the use of airport revenue is regulated by federal statutes and policies, including AIP grant assurances. Both federal law and the grant assurances strictly prohibit the use

Table 3. Examples of projects at airports and associated environmental market instrument.

Airport	Project Type	Project Description	Project Outcome	Applicable Environmental Instrument
Portland International Jetport, ME	Geothermal	HVAC system (120 wells) for new terminal; low-temp/low energy radiant floor.	REC production, carbon reductions through renewable energy generation and waste reduction; the system is expected to reduce oil used for the new terminal by 90%—nearly 102,000 gallons a year (Turkel 2010).	RECs
Albuquerque International Sunport, NM	Solar	Solar PV project (600 kW system).	Solar REC production, savings of over $65,000 per year; eliminated CO_2 emissions equivalent to 14,547 gallons of gasoline consumption each year (Whitson n.d.).	Solar RECs
General Edward Lawrence Logan International Airport, MA	Wind	100,000 kW produced annually by 20 small urban turbines; partnered with AeroVironment.	REC production, turbines will generate over 100,000 kilowatt hours of annual electricity, reducing carbon emissions by 97,500 pounds (Energy Groom n.d.).	RECs
Los Angeles International Airport, CA	Organic Waste Composting	Electricity is generated from methane gas, which is produced from 8,000 tonnes of food waste per year.	REC generation, carbon reductions through renewable energy generation and clean waste removal.	RECs, possibly offset credits
Philadelphia International Airport	Electric Ground Service Equipment	Electric baggage tractors and electric belt loaders replace their traditionally fueled counterparts.	AERC generation, avoids over 500 tons of ozone precursor over the life of the project.	AERCs
Gerald R. Ford International Airport	Gate Power/ PCA	Preconditioned air and ground power converter units avoid the use of APUs at the gate.	AERC generation, avoids over 100 tons of ozone precursor over the life of the project.	AERCs

of airport revenue for non-airport and non-revenue producing projects by all public and private airport sponsors that have received federal assistance. Specifically, airport sponsors are required to use airport revenue only for "the capital and operating costs of the airport, the local airport system, or other local facilities owned or operated by the airport sponsor and which are directly and substantially related to the air transportation of passengers or property."

This discussion of airport constraints is, consistent with the purpose of the *Primer*, focused on revenue opportunities related to carbon credits. Accordingly, initiatives that are purely cost-additive to airport sponsors—including the purchase of green power, RECs, and offset credits—are not discussed. Such purchases are, however, an area of interest to be explored in ACRP Project 11-01 (Topic 03-05), "Analyses of State and Federal Regulations that May Impede State Initiatives to Reduce an Airport's Carbon Footprint." There are reported examples of such purchases at Los Angeles (DOE n.d.b), Dallas/Fort Worth (Green Power Partner 2010), and Portland (EPA & DOE 2010) international airports.

1.4.1 Use of Airport Revenue and Revenue Diversion

There does not appear to be a likely violation of airport revenue use restrictions resulting from the on-airport installation of alternative energy systems or offset-eligible projects, provided that either (1) those facilities would be used directly by the airport or (2) the airport were compensated appropriately for the use of airport land. For example, an airport generating renewable power would likely have to retain any revenue accruing from the sale of excess power or RECs to a utility company or to a third party for its own use. As such, one interpretation could be that a municipal airport sponsor might be violating revenue use restrictions if it were to take the REC revenues "downtown," i.e., to use them for municipal purposes not related to airport operations without fair market value compensation to the airport. An analogous activity is that of revenue generated from mineral extraction as set forth in the 1999 Policy and Procedures Concerning the Use of Airport Revenue (FAA 2009).

In a power-purchase agreement (PPA)—a contract between an entity that generates power and an entity that purchases and consumes electricity where a third party owns and operates an alternative energy or offset-eligible project on airport property—the airport would need to be compensated for the fair market value of the property. In some circumstances, where a PPA project is conducted on property purchased with AIP noise grants, the FAA may demand repayment of the grants. The FAA is starting to look at the release of this land for non-aviation use.

1.4.2 Airport Layout Plan and Compatible Land Use

Before an airport sponsor can "sell, lease, encumber, or otherwise transfer or dispose of any part of its title or other interests" in the airport, the FAA needs to approve the action, as part of its grant assurances. Airport sponsors should coordinate with their Airport District Office before entering into long-term leases for renewable energy and offset-eligible projects that result in either a release of airport land or a change in the airport's land use. The FAA must approve all land uses on airport property. Should the land uses interfere with the safety and efficiency of the airport operation or other critical evaluation factors, they may not be approved. Wind farms and solar farms alike could have safety implications at the airport. While solar farms are an increasingly common site at airports, wind farms are not typically observed due to a number of factors, such as their size and potential interference with radar technology.

Over 15 airports around the country are operating solar facilities and airport interest in solar energy is growing rapidly. The FAA has published "Technical Guidance for Evaluating Selected Solar Technologies on Airports" (FAA 2010b). This guidance, published in October 2010, provides a checklist of FAA procedures to ensure that proposed photovoltaic or solar thermal hot water systems are safe and pose no risk to pilots, air traffic controllers or airport operations. This checklist should be reviewed in detail, as a starting point for all airport sponsors considering solar at their airport. Case studies of operating airport solar facilities are provided within the guidance document, including Denver International Airport, Fresno Yosemite International Airport, and Albuquerque International Sunport. The feasibility of solar projects, as well as other renewable energy projects on airport grounds, will be discussed in later sections of the *Primer*.

Land use in the vicinity of the airport is also governed by the grant assurances, which specify that it must be compatible to the extent reasonable so as to minimize interference with airport operations. However, airport operators do not directly control the use of off-airport land. This restriction would limit the ability of the airport sponsor to "partner" with an adjacent landowner to implement an offset-eligible project if that offset-eligible project is not compatible with the airport operation.

1.4.3 Use Agreements and Bond Resolutions

Airport-airline use and lease agreements provide the basis for the financial relationship between airports and airline tenants. Depending on the business relationship and associated provisions, airlines may retain the right to approve capital expenditures via Majority-in-Interest (MII) purview and in some cases operating budgets. Capital expenditures such as renewable energy projects and offset-eligible projects are unlikely to be excluded from airline MII purview; therefore the airport may be obligated to seek airline permission to undertake them. In the absence of an airline use and lease agreement, the U.S. Department of Transportation's *Policy Regarding the Establishment of Airport Rates and Charges* establishes the guidelines that airports must follow in determining which costs can be included in the airline rate base if a rate methodology is unilaterally employed by an airport.

Smaller commercial service airports and general aviation airports may not necessarily have use agreements with their tenants or rate resolutions that prescribe annual cost-related adjustments of rates and therefore may have less opportunity to recover capital or operating expenditures associated with renewable energy projects or offset-eligible projects from their tenants. As a result, these airports are more dependent on grant participation or are more likely to need a faster return on investment for these projects than larger commercial service airports, which could affect the structure of the transaction. For example, smaller airports may not have ready access to debt for these projects and may need to solicit private investment and associated sharing of risks and rewards.

Airports that issue general airport revenue bonds are subject to bond resolutions that describe the nature of the debt obligation, the security for the obligations, and the airport's duties to the bondholders, among other things. They commit the airport to generating annual revenues in excess of operating expenses and debt service to provide a cushion for bondholders (usually equal to 25%, referred to as the "rate covenant"). Before airports can issue more debt, they must meet the conditions required under the additional bonds test, which can be more onerous than the rate covenant. Bond resolutions also typically have restrictions on the sale or long-term lease of airport property. An airport's ability to add operating costs and debt are also limited by risk and market thresholds for leveraging future revenues.

Responsibility for debt repayment, increases in operating expenses, and associated impacts on tenant rates and charges are typically matters of negotiation between airports and tenants (although some airports do not have airline use and lease agreements and only need to consult with airlines regarding annual rates). Airport sponsors should review their legal documents to determine their requirements. Depending on the form of the agreement for the project, the associated cost may be defined as an operating expense or a capital expenditure. If it is an operating expense, tenants are less likely to have the right to veto the project. It is unlikely that bond resolutions or airport agreements would list and define these types of expenditures explicitly.

CHAPTER 2

Carbon Offset and Value Opportunities for Airports

2.1 Offset Credit Origination

Key Takeaways for Airports

- There are a handful of airport projects with offset credit potential but not all GHG emission reducing activities at an airport will result in offset credits that have value in carbon markets.
- Typically, offset credit buyers will want the offset projects to have been registered with an offset standard body.
- As new types of carbon offset projects become eligible for offset origination, airport sponsors should assess whether to retain the rights to each project's offset credits or to instead allow tenants to retain them.

A carbon offset project describes an activity that reduces, avoids, or sequesters GHGs in order to compensate for emissions occurring elsewhere. Offset projects can cover a wide variety of activities and installations. Theoretically, an airport sponsor could claim any activity that results in a net decrease in carbon emissions as an offset; however, not all offset activities carry monetary value in carbon markets. Buyers in the carbon market often want assurances that the offset credit they are buying is of a certain quality or type. Offset standards bodies serve an important role in the offset market by developing, verifying, and quantifying GHG emission reductions from various activities. An overview of offset standards bodies is contained in Section 2.2.1. Without the backing of an offset standard body, it may be difficult to create revenue from some projects that reduce GHG emissions.

Regardless of the offset project type or standards body, there are generally five common criteria that all offset projects must meet in order to ensure crediting for reducing GHG emissions (World Resources and World Business Council for Sustainable Development 2004):

1. Real—An actual unit of GHG must have been reduced, avoided, or sequestered.
2. Permanent—The activity must result in a reduction, avoidance, or sequestration that will not be reversed.
3. Additional—The project must have been undertaken in response to an incentive created by a carbon offset market. For example, the activity cannot have been required by law or cost effective not accounting for value of the offset credit.
4. Verifiable—The project sponsor has to be auditable to show that an actual reduction took place.
5. Enforceable—Projects generally have to be backed by legal contracts or other legal instruments that define their creation and ensure exclusive ownership.

In the United States, generally recognized project types can be broken into three main categories: (1) methane capture and destruction; (2) land use changes to sequester carbon dioxide; and (3) the destruction of industrial pollutants which are high global warming potential GHGs. Each project type presents unique challenges to airports, making feasibility of many of the most common offset project types unlikely as viable options for airports. The following is a description of the types of projects that generally fall into these categories and an exploration of an airport's potential to participate.

2.1.1 Airport Offset Project Applicability

Despite the growing categories of recognized offset projects, an airport's ability to participate in activities recognized by the leading offset standard bodies is currently limited. The types of GHG emission reduction projects that airports typically engage in do not align with many of the traditional offset program types recognized by U.S. offset protocols. Table 4 describes some potential project types that may be applicable to airports, based on typical airport operations. The following sections summarize common offset project types.

2.1.2 Methane Destruction

Methane (CH_4) gas capture and destruction is a recognized project type by most offset standard bodies. The requirements vary to some degree, but are generally two-fold: (1) capture of landfill gas (made up largely of methane gas) and (2) destroy through combustion the methane in landfill gas (De la Cruz 2010).

Table 4. Offset projects and airport applicability.

Project Type	Project Description	Airport Feasibility Notes
Landfill Gas	Install equipment to capture methane gas from a landfill; destruction could yield a usable energy source.	Potentially viable if airport landfill is currently in operation. Closed landfills can produce gas for approximately 10 to 30 years. New landfills pose a safety risk at airports and are prohibited, as specified in FAA Advisory Circular 150-5200-34.
Enhanced Wastewater Treatment	Install equipment at airport wastewater treatment plant to capture methane gas from wastewater.	Subject to an airport having a wastewater treatment facility on-site.
Organic Waste Composting	Collect food waste in airport terminal and send to a composting site for methane capture.	Examples of airports diverting organic waste from landfills to composting facilities have included Los Angeles, Oakland, Portland, and Seattle International Airports.
Forestry	Restore vegetation, avoid conversion of vegetation to commercial development, or add vegetation to airport property.	Forest that attracts wildlife is a risk to airport operations and safety. On-airport wildlife issues could be potentially avoided through careful selection of the appropriate type (grass, bush, or tree) and location (landside, remote airport property) of vegetation. To be creditable, a reforestation project would likely need to be additional to environmental mitigation requirements stemming from a regulatory decision.
Refrigerants	Switch to less GHG-intense refrigerants.	GHGs from refrigerants likely make up only a small fraction of airport emissions.

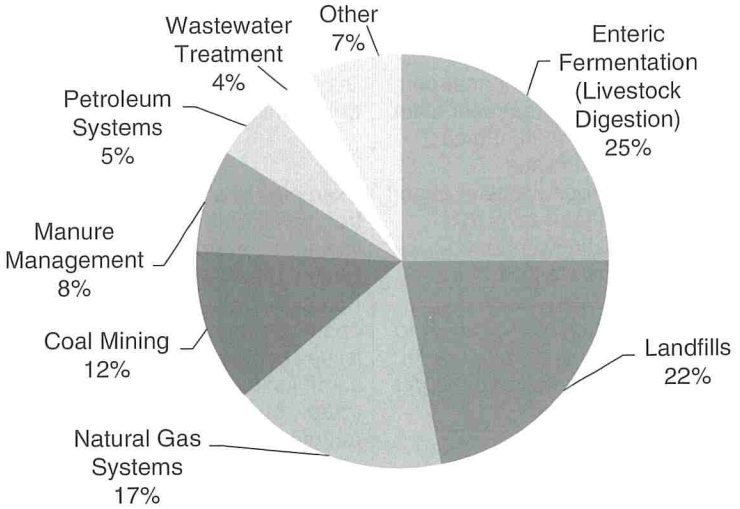
Key Takeaways for Airports

- The primary opportunity for a methane destruction offset project would be from an existing landfill on airport grounds.
- New landfills are prohibited at airports, limiting the applicability of this offset project type moving forward.

In its Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2008 study, the EPA estimates that methane emissions make up about 9% of all GHG emissions in the United States (EPA 2010). There are a variety of methane emitting sources in the United States; however, the leading sources are enteric fermentation (digestion from livestock), landfills, natural gas systems, coal mining, manure management (from livestock), petroleum systems, and wastewater treatment. Figure 2 presents more information on the relative contribution of these methane sources.

Operators of these various sources of methane gas have developed methods for capturing the gas by installing a system of wells, pipes, blowers, caps, and other technologies. After capture, methane is combusted and destroyed, usually by a flare or a boiler which combusts the gas in order to create heat for other processes such as electricity generation. When methane is combusted, the gas is destroyed and the byproduct of combustion emitted is carbon dioxide (CO_2) which has a much lower GWP. The result is a lower impact to GHG concentrations in the atmosphere compared to methane seeping into the atmosphere directly from the landfill or other methane source. The following are sources of methane emissions that are recognized by U.S. offset standards bodies to generate offset credits.

Landfills—Landfills remain the most common method for disposing of waste in the United States and a potential, albeit unlikely, methane capture and destruction project source for airports. The bacterial decomposition of solid waste in a landfill creates a landfill gas, which is primarily comprised of two GHGs: methane and carbon dioxide. With time—and if not collected, captured, and/or destroyed—landfill gas can be released into the atmosphere, adding to the overall concentration of GHGs. If captured, landfill gas can potentially serve as an energy source.



Source: US EPA. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2008. Washington, D.C., 2010.

Figure 2. U.S. methane emissions by source (average 1990–2008).

Safety regulations prevent airports from placing new landfills on airport grounds, limiting projects in this offset project category to airports with existing landfills.

Composting Organic Waste—Aerobic composting operations are recognized by some offset standard bodies and represent a potential offset project type for airport sponsors. Research has shown that in most landfill gas collection systems, for rapidly decaying organic waste such as food, a greater proportion of the methane will go un-captured in comparison to slower degrading waste. By diverting rapidly degrading food waste to aerobic composting operations and away from landfills, airport sponsors can avoid large amounts of methane emissions.

Wastewater Treatment—Wastewater from domestic and industrial sources is treated at wastewater facilities to remove certain organic and chemical matters. These processes produce and release methane. Some offset standard bodies are beginning to develop protocols for capturing and destroying methane from wastewater facilities.

There are other methane capture and destruction offset project types that likely have less applicability to airports. Most of the leading United States–based offset standard bodies allow methane destruction for coal mining to qualify for offset credit origination. Farmers and other managers of livestock often manage the waste produced from their livestock in tanks or ponds specifically designed for holding manure. These holding systems are often liquid-based systems that, with time and under anaerobic conditions, decompose and produce methane. Owners of manure management systems who install biogas control systems that capture and destroy the methane gas are often eligible for offset credits.

2.1.3 Land Use Changes

Key Takeaways for Airports

- Forest land is a natural carbon sink. The protection or enhancement of forest lands are common forms of recognized offset projects.
- Although no offset forestry projects at airports in the United States have been developed to date, the Montreal-Mirabel International Airport in Mirabel, Canada, is participating in a forestry project.
- Airport participation in forestry projects is limited due to the safety concerns associated with attracting wildlife to or near airports.

Forest land represents one of the largest natural carbon sinks on the planet. The maintenance, protection, and promotion of forestry is seen as a critical element in reducing carbon dioxide concentrations in the atmosphere. Forests are complicated, constantly changing, integrated systems of living organisms, in which carbon is continually absorbed and released by trees, soil, and other organic material. A 2009 study funded by the Royal Society and the Natural Environment Research Council showed that tropical forests absorb about 18% of the carbon dioxide added to the atmosphere each year from burning fossil fuels (Lewis 2009).

When forests or trees are disturbed by natural events like disease, pests, or fire, or when they are disturbed by manmade events such as harvests, the stored carbon dioxide can be released into the atmosphere. While new forests have the potential to absorb and store additional carbon dioxide, creating a net decrease in carbon dioxide in the atmosphere, existing forests, if they are cut down, have the potential to release the carbon dioxide already stored resulting in a net increase in carbon

dioxide in the atmosphere. For this reason, many offset standard bodies recognize both projects that create new forests, composed of tree and vegetation species that rapidly sequester carbon, and those that help ensure that existing forests remain in a form that continues to store carbon dioxide.

Airports face a number of hurdles in participating in these types of forestry offset projects. First, many airports do not have the acreage to plant a large number of trees or to convert non-forest land into forest land. Secondly, and perhaps more restrictive, FAA has safety concerns with attracting wildlife to the airfield or even close to the airport. Trees provide habitats to wildlife and therefore planting of any vegetation is carefully considered and often restricted by airport sponsors. For these reasons, airport participation in large forestry offset projects may be difficult, unless the land holdings of the airport were such that new forestry would not create any new safety concerns.

Case Study 1 examines a proposed reforestation project at the Montreal-Mirabel International Airport in Mirabel, Canada. The airport was approached by a forestry offset credit project developer to plant approximately 96,000 trees, which are expected to sequester more than

Case Study 1: Montreal-Mirabel International Airport, Mirabel, Canada

The Montreal-Mirabel International Airport in Mirabel, Canada, is a non-hub airport serving the needs of cargo carriers flying into and out of the province of Quebec. The airport is located 34 miles northwest of downtown Montreal. In 2009 Mirabel handled about 100,000 tons of cargo.

Aéroports de Montréal (ADM), a not-for-profit corporation responsible for the management, operation and development of Montreal-Mirabel Airport, was approached by CO_2 Environnement (the developer) to partner in a tree plantation/reforestation project that will result in the generation of reforestation offset credits. Reforestation offset credits are generated from projects that restore forests on land that was once forested. The developer specializes in reforestation by planting trees on land owned by its partners, which in this case is ADM. The reforestation project between ADM and the developer will begin when 96,000 saplings—jack pine, black spruce and white spruce, all of which are native to Quebec—are planted away from airfield activity between Montreal-Mirabel's east and west access roads, which connect the airport terminal building to the local highway. Over the lifetime of the project, the trees will create what is called a carbon sink where atmospheric CO_2 is sequestered through the natural process of tree growth. By this carbon sequestration, the developer will generate reforestation offset credits and sell them in the voluntary carbon market.

The project is expected to begin in July 2011 and is the first example in North America of an offset credit reforestation project at an airport. The developer estimates that 16,382 tonnes of CO_2 will be sequestered over a crediting period of 50 years, according to the quantification methodology ISO 14064-2. The project will be verified by Skoven Inc., a third-party carbon verifier, according to ISO 14064-3. The 16,382 reforestation offset credits will be issued to the developer when the trees are in the ground and Skoven Inc., has completed the verification audit. While the developer expects to sell the 16,382 offset credits on the voluntary market, ADM will not receive any financial benefit from the sale of the voluntary credits. ADM is largely interested in the environmental and community benefits associated with the project—namely aiding in the reduction of greenhouse gases and improved air quality. There can be great dis-

Case Study 1: (Continued).

crepancy in what offset credits can be sold for. In the United States, a reforestation offset credit might sell between US$3 and $15 on the voluntary carbon market. Therefore, the developer could expect to take in a one-time revenue between US$49,146 and $245,730 (ForestTrend n.d.). All preparation, planting, and maintenance service costs, as well as quantification, verification, and certification fees, are borne by the developer.

In the past, the developer has sold voluntary reforestation credits to paper mills, refineries, and financial institutions looking to retire the voluntary credits and claim the green benefit or resell the voluntary credits for profit. It is worth noting that while ADM can claim environmental goodwill by partnering with the developer and hosting forest growth, ADM cannot claim the carbon reduction—this goes to the end buyer of the voluntary credits.

The 79-acre project site at Mirabel airport is well suited for a reforestation project. The area was unused before the project and met reforestation project standards, and future tree growth will not conflict with airport operations. In order for the credits to be certified by CarbonFix, a leading carbon standards body for reforestation projects which is certifying the credits, ADM and the developer must state that neither the trees nor the project land is intended to be developed in the foreseeable future. However, in the event that ADM must remove some of the trees or a percentage of the trees die prematurely, surplus offset credits built into CarbonFix's portfolio of projects—required by the ISO 14064-2—will cover any reduction at the Mirabel site.

For an airport in the United States looking to host a reforestation project, there are many eligibility preconditions the project must meet. As well as meeting the eligibility preconditions, U.S. airports looking to host a reforestation project might not be permitted if it has accepted federal airport grants because these airports are regulated by federal statutes, policies, and Airport Improvement Program (AIP) grant assurances. The following issues might create challenges:

- Both federal law and the grant assurances strictly limit the use of airport revenue for non-airport purposes. "Airport revenue" is defined broadly and includes, by way of analogy, proceeds from timber sales, mineral extractions, and agricultural use on airport property, which is similar to this situation. Therefore, the airport might need to be compensated by the developer for the sale of the offset credits, minus the cost to the developer to generate the sale proceeds.
- Airports are not permitted to donate land for "goodwill" purposes, not even to their parent city, county, or state owner. Airport owners must charge a minimum of fair market value to lease property for non-aeronautical use, with the exception that subsidies may be offered in certain circumstances such as for community purposes to maintain positive airport-community relations, subject to restrictions. In the case of this tree plantation project, ADM is neither donating land nor leasing land to the developer. The project land will remain owned by the government even though the developer will plant trees and generate offset credits.

Provided U.S. airports can successfully navigate federal statues and policies, there exists wide potential for non-revenue and revenue earning reforestation projects on airport property that do not interfere with airport operations.

16,000 tonnes of CO_2. This case study could serve as a model for United States–based airports interested in hosting a similar project.

Case Study 1 is an example of a reforestation project. The following are examples of other forestry project types:

Urban Forestry—Some offset standard bodies have developed, or are developing, protocols for urban forestry. These protocols allow entities that plant trees along streets, near buildings, or on other property to be eligible to originate offset credits. An airport implementing an urban forestry offset program might line access roads or airport parking lots with trees to sequester GHGs. In terms of revenue opportunities, such a project is probably limited as the number of tonnes of CO_2e sequestered from such a project is likely to be minimal. The value of such a project would rest more in "green" branding than revenue opportunities.

Reforestation—A reforestation project generally involves restoring tree cover to an area that has been in a non-forest state for an extended period of time. Generally reforestation projects involve planting new trees and/or removing any impediments to natural reforestation. Impediments often include non-native species, pests, or manmade impediments preventing forest growth.

Improved Forest Management—Improved forest management (IFM) projects generally involve managing forests in such a way as to either maintain or increase the forest land's carbon stock. Eligible forest management activities often include removing diseased trees, managing competing brush and short-lived forest species, or increasing the stocking of trees on understocked areas.

Avoided Conversion—Finally, some landowners are eligible to claim offset credits simply by committing to keep their land in forestry. The justification for this type of project is that the land has more value to a landowner in a non-forest state than it does in forestry and without incentive, will eventually convert into a more profitable, non-forest state. Offset credits provide an incentive for the landowner to keep the land in forestry. IFM and avoided conversion projects would only be viable at airports with large forest holdings, a feature not common at most airports.

2.1.4 Industrial Pollutants

Key Takeaways for Airports

- Old equipment in airport facilities may contain ozone depleting substances (ODS), the destruction of which is a commonly recognized offset project.

ODSs have historically been used in a variety of applications including refrigerants, solvents, and fire extinguishing devices. As a pollutant, ODSs are more familiarly associated with their contribution to the depletion of the earth's ozone layer. However, many ODSs have extremely high GWP, and thus the prevention of their release can have substantial impacts on atmospheric GHG concentration levels. Many offset standard bodies recognize the destruction of ODSs, in order to prevent their release into the atmosphere as a viable carbon offset activity, eligible to originate offset credits.

ODS Destruction—Largely due to an increased awareness of the impact ODSs have on the depletion of the ozone layer, the use of ODSs has largely been phased out. At airports, some equipment, such as refrigeration units, still contain ODSs which can be released into the atmosphere as units are serviced, recycled, or disposed. Some ODSs have been replaced with hydrofluorocarbons (HFCs), which are ozone-friendly but have high GWPs.

2.1.5 Energy Efficiency

Key Takeaways for Airports

- Improved energy efficiency is generally a low cost method for lowering an airport's carbon footprint; however, limited opportunities exist for monetizing offset credits.

For most airports, reducing energy use or increasing energy efficiency onsite will be the lowest cost option for reducing their carbon footprint. Energy efficiency measures can include: switching fuels for boilers, heaters, and other fuel-burning equipment to fuels with lower GHG emissions; replacing older inefficient appliances with newer equipment that operate more efficiently; and improving insulation of terminals and other structures. At the international level, there has been some acceptance of energy efficiency measures as viable offset projects, allowing the sponsors of these projects to earn revenue from sale of offset credits. Projects that have successfully implemented energy efficiency measures and sold the associated offset credits have most often taken place in developing countries. However, there have been some examples of offset projects for energy efficiency in developed nations.

In the United States there is currently a limited market for energy efficiency offset credits. The majority of the major offset standards bodies do not recognize energy efficiency projects as an eligible offset project type. Project sponsors registering a project under an offset standards body that does recognize energy efficiency as a project category will likely find limited demand for the credits in the marketplace. Part of the lack of demand for energy efficiency offset credits is the expectation that these types of activities will not be recognized in future compliance markets. The major federal legislative proposals establishing a cap-and-trade have not recognized energy efficiency as an eligible project type. The same is true in California's emerging cap-and-trade program, expected to be the largest demand driver for compliance offset credits in the United States in the near future. In the Regional Greenhouse Gas Initiative's (RGGI) forming document, energy efficiency offset projects are contemplated; however, at this time there exists essentially no demand for offset credits in RGGI. An explanation of the RGGI program is included in Chapter 3.

Case Study 2 examines various projects that the Austin Bergstrom Airport has undertaken as part of a City Council resolution to reduce the city's carbon footprint. The case study examines both actual projects that the airport has invested in and the applicability of hosting an organic waste composting offset project. Additionally, the case study reviews the potential revenue opportunities from selling the credits associated with the various project types.

Case Study 2: Austin Bergstrom International Airport, Austin, Texas

The City of Austin's Department of Aviation (DoA) owns and operates Austin Bergstrom International Airport (ABIA), a medium-hub airport serving the Austin metropolis in central Texas. Having opened for passenger service in May 1999, ABIA is one of the newest airports in the United States and is a relatively energy-efficient, modern facility.

(continued on next page)

Case Study 2: (Continued).

Despite the absence of federal and state regulation governing carbon, the City of Austin has taken positive steps to initiate programs to tackle climate change. In February 2007, the City Council passed a resolution that directed its departments to begin taking action in a variety of areas. The four main components of Resolution No. 2007215-023 include: (1) a carbon neutrality goal for all city facilities by 2020, (2) increased conservation efforts, (3) new energy efficiency initiatives, and (4) renewable energy programs. To implement carbon reduction initiatives, the DoA has capitalized on funding available from Austin Energy, the local utility provider.

While the DoA has undertaken a number of projects that reduce carbon emissions over the past ten years—specifically energy efficiency improvements and the installation of solar panels to reduce electricity demand—they have not yet pursued revenue opportunities associated with selling energy and environmental commodities such as voluntary carbon offset credits, solar renewable energy credits (RECs), and energy efficiency credits. From the DoA's perspective, the monetary value of selling away their claim to "going green" must be compared with the goal of reducing the ABIA carbon footprint. The following sections estimate potential DOA revenues resulting from (1) eligible carbon offset projects, (2) REC generation, and (3) energy efficiency improvements.

Carbon Offset Credits—Offset credits can be generated by composting organic waste that is normally sent to the landfill. Such waste is produced at airports by concessionaires (food scraps) and grounds maintenance operations (yard trimmings). Assuming that 1.25 tonnes of mixed organics are generated daily at ABIA, the DoA could reduce carbon output by an estimated 233 tonnes (EPA—Climate Change Waste n.d.) per year if organic waste was composted instead of sent to the landfill. The average price of a voluntary carbon offset credit in the United States, as measured by the transactions from projects registered in the Climate Action Reserve, is between $3 per tonne of CO_2e and $10 per tonne of CO_2e. Offset credits that are expected to be eligible in California's cap-and-trade program, scheduled to begin in 2013, are trading at the higher end of that spread while other offset credits are trading closer to $3 per tonne. Organic waste offset projects are not currently one of the accepted methodologies in California's proposed cap-and-trade. With these expectations, the DoA could earn up to $699 annually from the sale of voluntary carbon offset credits from composting mixed organics instead of sending the organics to a landfill.

Renewable Energy Credits—By the end of 2011, the City will have three solar arrays in operation at ABIA. The arrays of 40 kW, 80 kW, and 115 kW output will all be owned by the community-owned electric utility company Austin Energy. The 40 kW and 80 kW solar arrays were funded through Austin Energy's "Solar Explorer Program" launched in 1997. The newest array, 115 kW in size, is part of a $4.2 million dollar Leadership in Energy and Environmental Design (LEED) certification project for the ground transportation service area at ABIA. Mounting and electrical connecting fees of $500,000 were covered by the DoA. The DoA pursued all three photovoltaic projects for public relations reasons and did not seek to maintain the SRECs (SRECs are a class of RECs produced using solar energy) or enter into a Power Purchase Agreement (PPA) with Austin Energy to secure reduced energy rates.

Case Study 2: (Continued).

Had the DoA had the option to maintain the SRECs associated with the solar arrays, potential revenue could be generated by selling the SRECs (as opposed to a generic renewable mix) directly to Texas electricity suppliers who need to meet the state's Renewable Portfolio Standards (RPS). Combined, all three arrays are projected to produce 337 MWh yearly. 1 MWh of renewable energy production earns one SREC, giving the DoA the potential right to sell 337 SRECs. The 2010 mean price for one REC in Texas was $1.00, with the spread between $.85 and $1.15. If prices for SRECs in Texas remained at $1, as expected, the potential revenue generated for the DoA would be $337 yearly. However, in the Northeast and Mid-Atlantic region of the United States, SRECs are traded between $140 per MWh and $650 per MWh offering a much greater financial incentive for airports. For instance, a Northeast airport hosting an equivalent solar array output has the potential to earn $198,830 yearly given the regional average of $590 per MWh SREC price.

There are two major factors contributing to the high disparity in SREC price between the Northeast region and Texas. First, electricity suppliers in the Northeast region are currently under an obligation via the state RPS—to incorporate a higher percentage of solar generated electricity compared to electricity suppliers in Texas. As a result, there is a greater demand for SRECs in the Northeast region which drives up the price of SRECs. Second, in the Northeast region it is relatively more expensive to supply SRECs to the marketplace due to lower solar radiation in the Northeast region than compared to Texas; equivalent output of electricity from a solar array in the Northeast region and Texas would require a much larger solar array in the Northeast to compensate for the lower solar radiation. The relative lack of supply drives up the price of SRECs as well.

Energy Efficiency Credits—The market for energy efficiency credits, or "white tags," is still immature in the United States and no market currently exists in Texas. The value associated with implementing energy efficiency projects is primarily limited to costs savings by reduced energy expenditures.

An energy company carried out a detailed assessment of the ABIA facilities and identified potential for a $258,724 reduction in annual energy costs by reducing energy consumption by 2,169,970 kWh. This equates to a 12% reduction in electric and gas bills at ABIA (based on the period of September 2006 through August 2007). The estimated installation cost of the upgrades is $1,453,170, equaling a 5.62-year payback before eligible rebates are applied.

2.2 Voluntary Carbon Markets and Initiatives

Key Takeaways for Airports

- Offset projects must align with credible standards and be verified and sold.
- Voluntary offset markets in the United States offer limited liquidity and value at this time.

The voluntary carbon market is composed of (1) Buyers—generally entities that are not required by law to make GHG reductions but wish to purchase offset credits to "offset" an emitting activity; and (2) Sellers—entities that reduce GHG emissions directly and wish to sell the benefits of that reduction. Airports that sponsor offset projects onsite will find offset credit buyers in the voluntary market driven primarily by the following two factors:

1. Purchasing offset credits that are expected to be used in a future compliance market, in advance of regulation, can be a strategy to mitigate future regulatory risk. However, there is some risk that the regulatory structure will not be implemented as expected, in which case the offset credits would likely have less value.
2. Entities may be interested in enhancing their brand and acting as environmental stewards by purchasing offset credits to claim a lower carbon footprint. Due to certain capital restrictions discussed previously in the *Primer,* airports sponsors are unlikely to be purchasers in the voluntary carbon market for stewardship purposes.

The following sections provide examples of programs and initiatives operating in the voluntary carbon market.

2.2.1 Offset-Based Programs

Key Takeaways for Airports

- Offset standards bodies establish criteria and protocols for developing, quantifying, and verifying GHG inventories.
- Each offset standards body has its own process for registering a project and issuing offset credits.

While an offset credit can represent any reduction in GHG emissions, only some GHG reduction activities are likely to create opportunities for additional revenue. In the United States' voluntary market, offset standards bodies have specific project types and procedures that project developers can follow in order to originate an offset credit. The specific project-type rules are often called "offset protocols." Buyers in the voluntary market generally prefer to purchase an offset credit from one of these recognized and credible bodies to ensure the validity of the offset credit. Some offset projects, certified under one of the leading standards bodies, may provide project owners a fast track to being certified under a future regulatory program. The leading standards bodies using industry accepted offset protocols include the following:

- **The Verified Carbon Standard (VCS)** is the most widely used quality assurance program to account for GHG reductions and credits in the voluntary carbon market worldwide. The program sets out processes for approving new project methodologies, approving independent auditing bodies, and issuing and listing GHG credits in a registry system. VCS-approved carbon offset credits are registered and traded as Verified Carbon Units (VCUs), with one VCU representing emission reductions of one metric tonne of carbon dioxide.
- **The American Carbon Registry (ACR)** is the first private voluntary GHG registry in the United States. ACR has numerous functions and responsibilities including extensive experience in carbon offset issuance and development of carbon offset protocols as well as online transaction and retirement reporting. ACR has issued over 30 million offset credits and is one of the most widely used voluntary carbon market registries in the world.
- **The Climate Action Reserve (CAR)** is a national offsets program that is focused on the United States carbon market. CAR is known for establishing standards for quantifying and tracking GHG emissions reduction projects, providing oversight to third-party verification bodies, and tracking carbon credits called Climate Reserve Tonnes (CRTs).

There are a number of common steps that an airport project developer must go through in order to get a project registered with any of the standard bodies. There will need to be a review of the project plan details, which include things such as a project description, ownership title, etc. It may often include a review of the project-type eligibility to make sure the project complies with the standard criteria. The eligibility criteria specify characteristics a project must have in order to register with the standard, as well as the conditions under which it will issue offset credits to a project.

There will then be project validation and verification by a third party, which will consist of an assessment of the project for validation as well as the GHG emission reduction/removal methodology for verification. The validation and verification process can take anywhere from two weeks to three months, as the level of detail is very project-specific. Once the project has been validated and verified, the project developer will receive a report and statement which will be submitted to the standards body. If the project is approved, the standards body will officially register the project and then issue the offset credits, assigning title assurance and a unique serial number identifier to ensure that each metric tonne is validated and traceable to its source.

Each of the standards bodies have their own specific process of assessment that a project must go through in order to become registered. Additionally, there is no set timeline or timeframe for the registration process, being that it is on a very project-specific basis. Figure 3 highlights the process for registering a project under some of the most widely used offset standard bodies.

An airport will likely incur some administrative and transaction costs associated with registering with offset standards bodies and being issued offset credits. Each offset standard body has a unique fee structure but generally assesses fees for setting up an account, submitting a project and issuing offset credits. Table 5 displays CAR's fee structure; similar fees can be expected from registering a project with other offset standard bodies.

2.2.2 Legally Binding Voluntary Programs

The Chicago Climate Exchange (CCX) was established in 2003 and represented North America's only legally binding, voluntary GHG reduction system. Participants of the program were

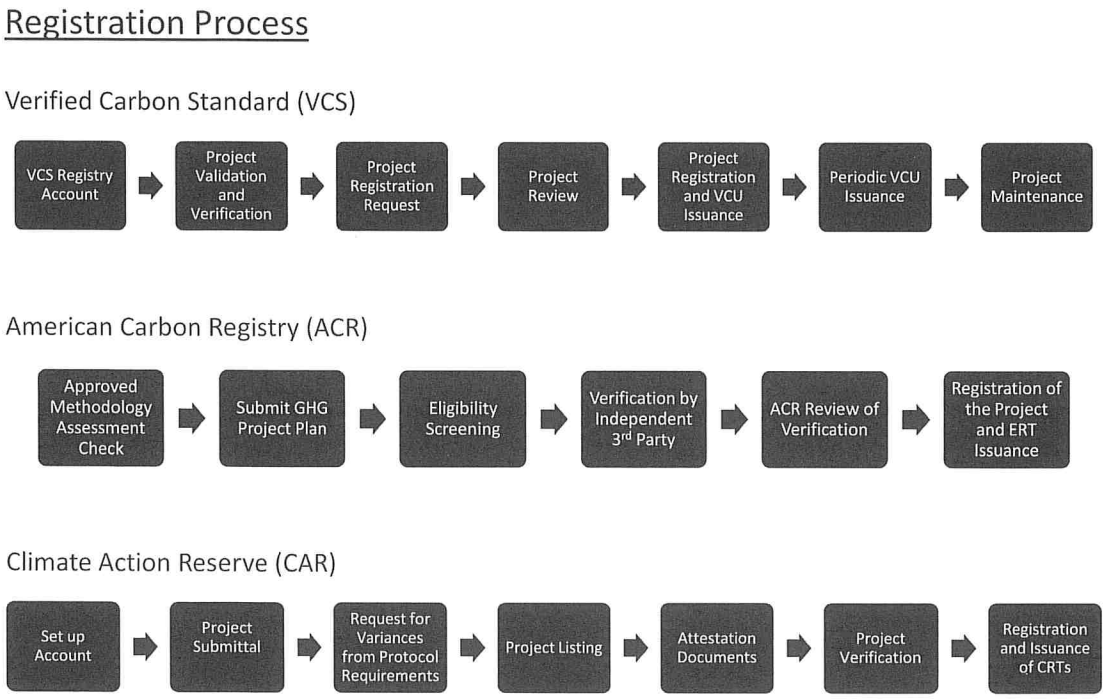


Figure 3. Prominent U.S. offset program registration process.

Table 5. Climate action reserve fee structure.

Climate Action Reserve (CAR) Fee Structure	
Account Setup Fee	$500
Account Maintenance Fee (annual)	$500
Project Submittal Fee (per project)	$500
Climate Reserve Tonne Issuance Fee (per offset credit issued)	$0.20

Source: Climate Action Reserve. *Operating Procedures,* January 28, 2011.

generally companies or other organizations that voluntarily committed to reducing their aggregate emissions by 6% by 2010. Participants committed to reductions were issued allowances in accordance with their emission baseline and reduction schedule planned for the length of the commitment period—through 2010. Municipalities that were CCX members and own airports include the City of Boulder, CO (Boulder Municipal Airport), and the City of Fargo, ND (Hector International Airport). The CCX had its own offset registry program that allowed qualifying offset project owners to register their projects and generate offset credits that could be used by participating companies toward their reduction commitments. The program was not continued beyond 2010. With the prospects of a federal cap-and-trade program seriously in doubt, at least in the near term, and almost no activity on the exchange for much of 2010, the exchange closed.

2.3 Role of the GHG Inventory in Airport Carbon Management

Key Takeaways for Airports

- GHG inventories allow airports to calculate emissions and measure reductions from certain activities.
- Inventories are a useful tool for airports wishing to reduce their carbon footprint. They provide a standardized method for measuring emissions and reduction activities.
- Establishing an airport-wide inventory is not a prerequisite to sponsoring an offset project but knowing the emissions associated with the project source is required for project verification.

Except for a few airports reporting under EPA's mandatory GHG Reporting Rule, there is currently no federal regulatory requirement for airport operators to track, measure, and inventory their GHG emissions from stationary sources. Documenting GHG emissions in order to receive credit for reductions in the future—also known as establishing or protecting the baseline—is an important concept for airport owners to understand. A baseline expresses what emissions would be in a business-as-usual scenario or were at a defined period of time.

GHG inventories are not carbon markets, but are nevertheless important to understand in the context of carbon markets. Accounting for carbon emissions is a prerequisite first step to defining reductions. Further, in the event that airports come under the compliance umbrella of a carbon cap-and-trade system, the ability to show historical reductions in GHG emissions may

result in early action credits or lower compliance requirements. Many of the carbon offset activities herein will require the establishment of baseline emissions.

An airport operator interested in measuring and reducing their carbon footprint may wish to measure GHG emissions in order to quantify the reduction in emissions resulting from their initiatives. In some instances an inventory may be required by a regulatory body in order to get approval for airport construction projects. Often these requirements are limited to considering the potential GHG emission impacts of a proposed project. In some cases, airports will be required to report their GHG emissions under EPA's GHG Reporting Rule. These airports are required to account for the collective emissions from most GHG emitting sources.

Standardized registries have been developed by a number of organizations in order to aid the development of GHG inventories. *ACRP Report 11: Guidebook on Preparing Airport GHG Emission Inventories* provides considerable guidance to airport operators on developing GHG inventories (Kim 2009). In developing an inventory, airport operators should consider following the methodologies provided by some of the leading registry bodies in order to maximize the credibility and accuracy of the inventory.

The Climate Registry (The Registry) is a nonprofit organization formed to create consistent GHG emissions standards and reporting methods for businesses, municipalities, and other organizations. Participation in The Registry is completely voluntary but the data from each of the entities must be independently verified to ensure accuracy. As of April 1, 2011, The Registry had 430 members nationwide (The Climate Registry n.d.). The Port of Portland participates in The Registry and emissions from Portland International Airport, along with their other facilities and business activities, are reported and independently verified on an annual basis. A number of other transportation companies also participate in The Registry including the Utah Transit Authority, Amtrak, and Virgin Airlines.

The Carbon Disclosure Project (CDP) is an international organization based in the United Kingdom, which works with shareholders and corporations to disclose the GHG emissions of major corporations. In 2008, the CDP reported emissions data for 1,550 of the world's largest corporations, accounting for nearly 26% of global emissions and representing, in total, over 3,000 organizations in 60 different counties (Carbon Disclosure Project n.d.). The organizations measure and disclose their GHG emissions and climate change strategies in order to set reduction targets and make environmental performance improvements. The CDP represents 534 institutional investors with a combined $64 trillion under management. Internationally there are quite a few airports that participate in the CDP, including Copenhagen Airport, Manchester Airport, Airport of Thailand, and several others.

In June 2008, the annual assembly of the Airports Council International—Europe (ACI Europe) adopted a resolution on climate change when its member airports committed to reduce carbon emissions from their operations, with the ultimate goal of becoming carbon neutral. One year later, at the 2009 annual assembly, ACI Europe launched *Airport Carbon Accreditation,* allowing the assessment and recognition of participating airports' efforts to manage and reduce their CO_2 emissions.

Airport Carbon Accreditation is an independent program to enforce the accreditation criteria for airports on an annual basis. The administration of the scheme is overseen by an advisory board.

Airports must have carbon footprints independently verified in accordance with ISO 14064 (ISO n.d.). Evidence of this must be provided to the administrator together with all claims regarding carbon management processes, which must also be independently verified.

Table 6 lists airports that have all become Airport Carbon Accredited since the launch of the program in June 2009. These airports currently account for over 34% of European passenger traffic.

Table 6. ACI Europe carbon accredited airports.

Carbon Accredited Airports		
Paris-Charles de Gaulle Airport	Dublin Airport	Stockholm-Arlanda Airport
Paris-Orly Airport	Cork Airport	Stockholm-Bromma Airport
Amsterdam Airport Schiphol	Shannon Airport	Umeå City Airport
Athens International Airport	Dubrovnik Airport	Göteborg Landvetter Airport
Oslo Airport	Frankfurt Airport	TAG Farnborough Airport
Trondheim Airport, Værnes	Antalya Airport	Istanbul Atatürk International Airport
Kristiansand Airport, Kjevik	Manchester Airport	Ankara Esenboğa International Airport
London-Heathrow Airport	Prague Airport	Izmir Adnan Menderes International Airport
Bologna Airport	Milan-Malpensa Airport	Zürich Airport
Brussels Airport	Milan-Linate Airport	

Source: Airport Carbon Accreditation. *Airport Carbon Accreditation.* http://www.airportcarbonaccreditation.org/ (accessed April 12, 2011).

CHAPTER 3

North American Compliance Carbon Markets

Key Takeaways for Airports

- The only compliance carbon markets in the United States take place at the regional and state levels.
- Airports are not currently regulated entities under any compliance cap-and-trade market and are not expected to be in the near future.
- Carbon market opportunities for airports at this time will largely remain in the voluntary market.

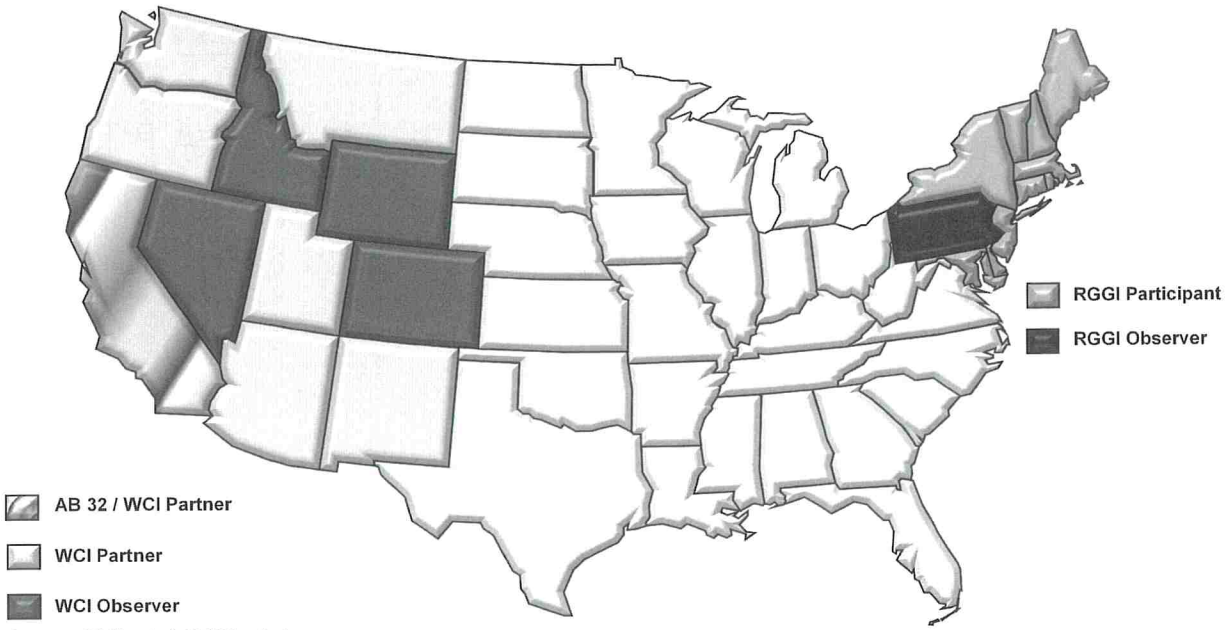
Currently, the only mandatory operating carbon market in North America is the Regional Greenhouse Gas Initiative (RGGI), covering emissions from power generators in parts of the Mid-Atlantic and New England regions of the United States. No comprehensive federal or other carbon markets are operational and there is little momentum in Congress to pass such legislation at this time. The Canadian government has announced its intentions to wait until the United States acts before enacting a GHG cap-and-trade scheme. Other states and regions, California, for example, are progressing with the implementation of their own carbon cap-and-trade programs. Figure 4 summarizes states that are participating or have committed in the future to participate in some form of state or regional cap-and-trade program.

Despite a varied level of commitment to reduce emissions from a number of states, the ten RGGI states and California are currently the only states with potential compliance demand for offset credits. Demand in RGGI states is currently very low, as most regulated entities have sufficient allowances to meet their compliance requirements. California regulated entities are likely to have more demand, although the compliance market in California is just developing, and the cap-and-trade program is not scheduled to begin until 2013.

3.1 State and Regional Regulatory Compliance Markets

Key Takeaways for Airports

- The United States state and regional compliance markets offer limited opportunity for airport participation at this time.
- RGGI allows offset credit use for compliance, but demand in the market has yet to materialize.
- The California market represents the most likely source of demand for offset credits once it is fully implemented in 2013.



Source: (WCI n.d. & RGGI n.d.a.)

Figure 4. U.S. regional GHG initiative participation.

3.1.1 Regional Greenhouse Gas Initiative

RGGI is the first operational regional mandatory climate change program in North America. RGGI regulates the CO_2 emissions of fossil fuel-fired power plants located in participating New England and Mid-Atlantic states. Currently 10 states are signatories of RGGI: Maine, New Hampshire, Vermont, New York, Massachusetts, Rhode Island, Connecticut, New Jersey, Delaware, and Maryland. New Jersey, however, announced that it will not participate in RGGI beyond 2011.

In its current form, RGGI utilizes a market-based system to reduce CO_2 emissions from the power sector through cap-and-trade. Covered generators are collectively required to hold emissions flat from the initial implementation date in 2009 through 2014 and then decline 2.5% per year through 2019. RGGI's ultimate goal is to achieve CO_2 emission reductions at least 10% below the 1990 level by 2020 (RGGI n.d.b). RGGI only applies to fossil fuel-fired electrical generating plants with a rated capacity equal to or greater than 25 megawatts (MW).

Offset credits are permitted to be used for compliance, but only for a small fraction (currently 3.3%) of a regulated unit's compliance obligation. At this time, only the following five project categories are eligible to generate CO_2 offset credits in RGGI:

- Landfill methane capture and destruction;
- Reduction in emissions of sulfur hexafluoride (SF_6);
- Carbon sequestration due to afforestation;
- Reduction or avoidance of CO_2 emissions from natural gas, oil, or propane end-use combustion due to end-use energy efficiency in the building sector; and
- Avoided methane emissions from agricultural manure management operations.

A total of 11 auctions have been held. The auction clearing price has steadily decreased since the second auction, with the most recent auctions clearing at or near the statutory minimum reserve price of $1.86 per allowance, an indication that the program is over-supplied with emission allowances (RGGI n.d.b.).

With the program over-supplied, and demand for allowances and offset low, regulated entities in RGGI are likely to have minimal demand in the near future for airport offset credits.

No airports or airport-owned facilities currently come under the direct compliance umbrella of RGGI. Compliance costs from regulated power producers will likely be passed through electricity purchases to end-users such as airports; however, given current low pricing levels, the impacts in the short term are expected to remain minimal.

3.1.2 California Assembly Bill 32

California passed the California Global Warming Solutions Act in 2006, which is commonly referred to as Assembly Bill 32 (AB 32). AB 32 requires the California Air Resources Board (ARB) to develop a GHG reduction and mitigation plan through 2020. On December 16, 2010, ARB voted 9 to 1 in favor of cap-and-trade program rules solidifying a 5-year process that began with the passage of the landmark climate change legislation, California AB 32.

The cap-and-trade program is expected to begin in 2013 for electricity generators and industrial facilities, while fuel suppliers will come under the cap in 2015. Compliance periods will occur in 3-year blocks, with the exception of the first compliance period, which will only encompass 2013 and 2014. The first allowance "true-up" will be in 2015 when regulated entities will be required to retire allowances and a limited amount of offset credits, if desired, for their 2013 and 2014 emissions.

The program will require electricity-generating facilities, industrial facilities, and suppliers of natural gas and other fuels to account for their emissions (downstream emissions in the case of fuel suppliers) each year. The rule enumerates ten specific industrial processes, along with facilities that generate their own electricity, and generally includes facilities with stationary fossil fuel combusting units with emissions in excess of 25,000 tonnes of CO_2e (EPA—California, Air Resources Board n.d.). While the enumerated processes identify processes and operations specifically designed to be covered by the program, any facility with emissions greater than 25,000 tonnes of CO_2e could be covered. Thus, airports in California with stationary emissions in excess of 25,000 tonnes of CO_2e may be regulated should the rules be adopted in their current form.

As regulated entities anticipate future compliance requirements, the market for offset credits in California has already started to develop. The following are four offset project types expected to be eligible in California:

- Urban Forestry,
- Ozone Depleting Substances Projects,
- Livestock Manure Projects, and
- Forestry Projects.

AB 32 was designed to eventually be implemented with a federal or regional cap-and-trade program. California was an original partner of the Western Climate Initiative (WCI), and would likely merge with other states and provinces should enough partner jurisdictions agree to participate.

3.1.3 Western Climate Initiative

In 2007, the governors of Arizona, California, New Mexico, Oregon, and Washington began working toward the establishment of a regional cap-and-trade program to regulate GHG emissions in the region. The governors of Montana and Utah, and the premiers of British Columbia, Manitoba, Ontario, and Quebec, later joined the effort to collectively form the WCI.

On September 23, 2008, the leaders of the member states and provinces (the Partners) released a design recommendation paper which was intended to serve as the framework for a cap-and-trade GHG reduction scheme.

The points of regulation for the WCI-proposed cap-and-trade program are generally: (1) the point of combustion for electricity producers; (2) the point of combustion for industrial facilities that directly emit 25,000 tonnes CO_2e or more per year; and (3) fossil fuel suppliers for emissions associated with the end-use of their sales (WCI n.d.). Implementation by each state and province of the WCI cap-and-trade program is dependent on that state or province passing legislation that adopts the scheme.

Thus far, it appears as though only California (linking the cap-and-trade from AB 32), British Columbia, and Quebec have taken the necessary steps in order to be prepared to participate when the program begins in 2013, although it is possible that roadblocks still exist, even for these jurisdictions. New Mexico has passed rules to implement a state cap-and-trade program, should they fail to participate in WCI; however, a political battle is currently being waged that may derail any cap-and-trade participation in the near future.

3.2 Federal Approaches to Limiting GHGs

Key Takeaways for Airports

- Legislation creating a federal compliance cap-and-trade program is unlikely in the near future—little legislative momentum exists at this time.
- Without legislation the voluntary market will be the primary market for airport offset credits.

3.2.1 Legislative Attempts

Numerous attempts have been made in Congress to enact legislation that would place a binding cap on total United States emissions; however, to date, no bill has successfully passed through both Houses of Congress. Further, very little momentum exists in Congress at this time to set limits on GHG emissions. In June 2009, the House of Representatives passed the American Clean Energy and Security Act of 2009 (ACES), marking the first time a comprehensive climate change bill passed either House of Congress. The economy-wide carbon cap-and-trade bill called for reduction of GHG emissions to 83% below 2005 levels by 2050 (Committee on Energy and Commerce June 2009). Despite an unprecedented level of industry consensus on many core issues contained within the proposed legislation, the Senate was unable to garner enough support for a companion bill, leaving the future of carbon legislation in a state of relative flux. Under ACES, neither airports nor airlines would have been directly regulated, although both would have likely seen increases in the costs of fuel and electricity due to upstream regulation.

3.2.2 Regulatory Approaches

In the absence of specific federal legislation regarding GHGs, the EPA has been exercising Clean Air Act (CAA) authority to regulate GHGs, consistent with the 2007 U.S. Supreme Court decision in *Massachusetts v EPA* (Massachusetts v EPA 2007). The Court ruled that the GHGs

Key Takeaways for Airports

- The EPA currently has authority to regulate GHG emissions and is implementing a series of regulations to track and limit GHG emissions.
- Current regulations do not create any extra demand for offset credits. Depending on how regulations evolve, offset credits could serve as a compliance option for regulated entities.
- Airports (with stationary sources emitting less than the 25,000 mtCO_2e/yr) do not currently come under the purview of EPA GHG regulations and are not expected to in the near future.

were considered to have the potential to impact the environmental and human health, which falls under the jurisdiction of the EPA to assess and regulate. This authority originates from existing provisions contained within the CAA, which was originally passed by Congress in 1970, with some significant amendments being added over the last 40 years. EPA has initiated a number of regulations covering GHGs impacting both mobile and stationary sources under the CAA which are summarized in Table 7.

Table 7. Summary of EPA GHG regulations.

Rule	Overview	Airport Applicability
Mandatory GHG Reporting Rule	- As of January 1, 2010, large emitters of GHGs must inventory and report GHG emissions. - General threshold for reporting is 25,000 mt CO_2e/yr additive of all stationary sources.	- Large airports are required to report (i.e., Boston Logan Airport's emissions are greater than 25,000 mtCO_2e/yr threshold and it is required to report).
Motor Vehicle GHG Standards	- Effective January 1, 2011, vehicle manufacturers have emissions target for light duty vehicles. - Light duty vehicles include passenger cars, light duty trucks and medium duty passenger vehicles.	- Rule directly regulates vehicle manufacturers, but could impact airport vehicle purchases in the future (i.e., cost pass through).
GHG Permitting for New and Modified Large Sources	- New or modified sources of GHG emissions need to address GHG emissions in permitting. - New facility resulting in GHG emissions of 100,000 tons CO_2e per year. - Modification to an existing facility resulting in GHG emissions in excess of 75,000 tons CO_2e per year.	- An airport would only be impacted by these rules if it exceeded new or modified facility emissions, thresholds.

Source: EPA - Climate Change. *Regulatory Initiatives*. http://www.epa.gov/climatechange/emissions/ghgrulemaking.html (accessed April 21, 2011).

CHAPTER 4

State of the Global Carbon Markets and Aviation: Regulatory Requirements and Voluntary Stewardship

While most traditional pollutants have local impacts, the increase of GHG concentrations in the atmosphere presents a unique environmental policy issue, because GHG emissions are global and collective in nature. Many proponents of a market-based solution to reducing GHG emissions envision a global market for allowances and offset credits where every GHG emitting person, company, or government in the world would be linked by a common regulatory cap-and-trade system and would be required to retire an allowance or offset credit to account for all emissions. Allowances and offset credits would then be tradable across national borders while collectively the world cap would steadily decline, ensuring lower concentrations of GHGs and slowing the impacts of global warming.

The following section describes the current state of carbon markets internationally. Because the United States does not have a national compliance carbon market at this time, it is important to look at operational compliance markets, like Europe and New Zealand, for guidance on how the United States compliance market might operate.

4.1 Global Compliance Carbon Market Overview

Key Takeaways for Airports

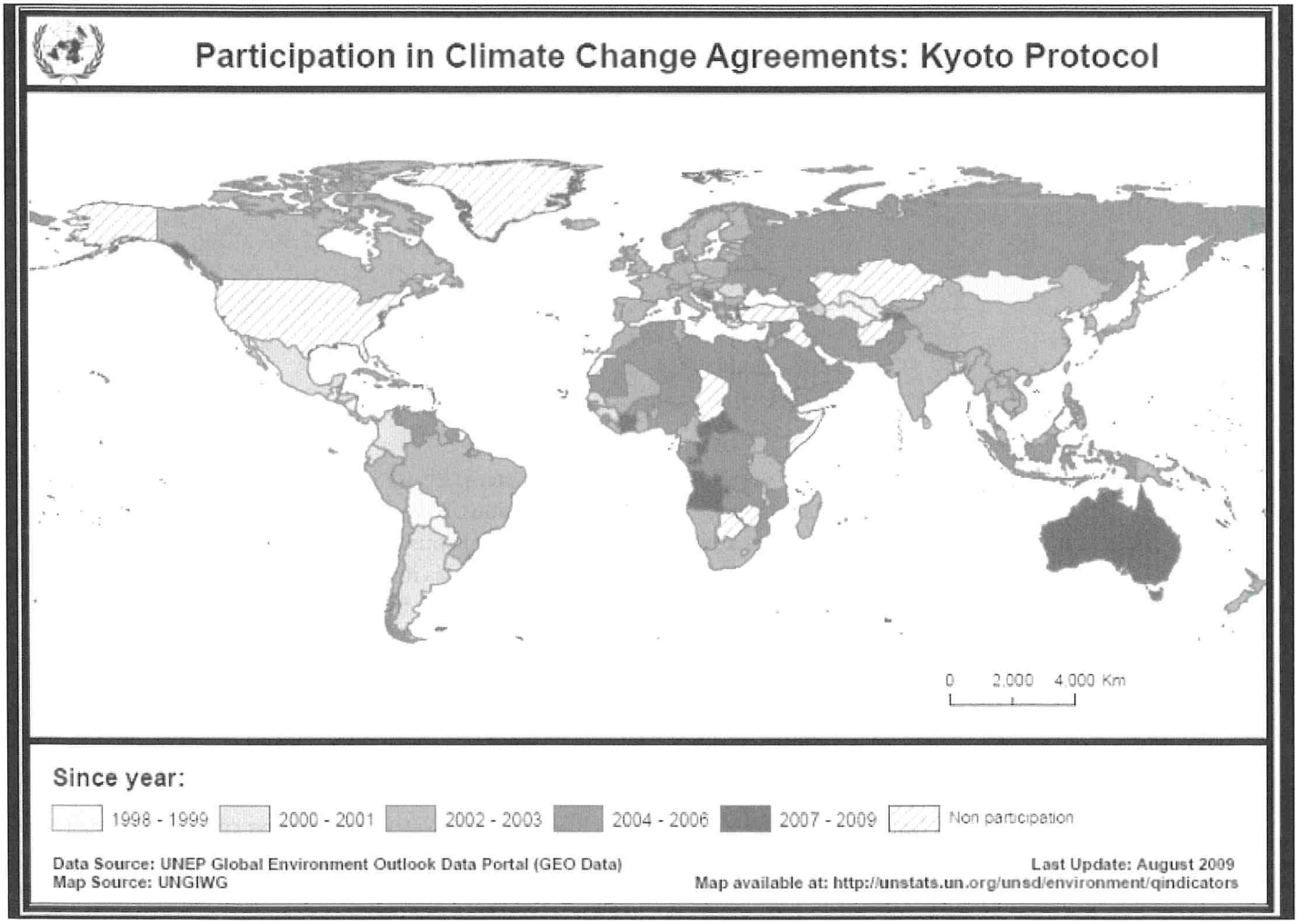
- No operating compliance carbon markets target airports themselves as regulated entities.
- Global carbon offset credit markets exist at this time to serve international markets.
- By regulating aircraft emissions, Europe's cap-and-trade scheme will be the first to regulate existing emission sources from the aviation sector, beginning in 2012.

The global carbon market is characterized by national policies driving compliance markets and voluntary emission trading programs. Voluntary emission trading occurs both regionally and globally, through a number of different protocols, largely to meet individual and corporate altruistic initiatives to claim emission reductions. The United Nations Framework Convention on Climate Change (UNFCCC) is the predominant forum for international discussions and agreements relating to climate change. The Kyoto Protocol Treaty is an international and binding agreement to reduce GHG emissions for industrialized countries and to promote clean develop-

ment in less developed nations. This agreement came out of the Kyoto UNFCCC conference in Kyoto, Japan, in December 1997. A total of 37 industrialized nations ratified the Kyoto Protocol, linking them to meet binding national emission reduction commitments (an average of 5% from 1990 emission year baseline) over the 2008–2012 time period. The United States is the only major developed economy not to ratify the Kyoto Protocol and take on binding emission reduction targets. Although most countries committed to Kyoto emission reduction targets have developed national plans for meeting emission reduction targets, Kyoto also establishes global carbon offset programs, known as flexibility mechanisms, to provide additional opportunities for meeting targets. Figure 5 presents a summary of Kyoto participation status by country.

The Kyoto flexibility mechanisms include:

- Clean Development Mechanism (CDM): a developed nation with emission reduction commitments sponsors an emission reduction project in a less developed nation in return for a certified emission reduction ("CER") credit.
- Joint Implementation (JI): a country with an emission reduction commitment hosts an emission reduction project to generate emission reduction units (ERUs). The host country essentially gives away the right to claim these reductions and sells them to another country.



Source: United Nations - Environmental Indicator. *Environmental Indicator - Climate Change*. http://unstats.un.org/unsd/environment/Participation_ClimateChangeAgree.htm.

Figure 5. Summary of global Kyoto participation.

A UNFCCC body reviews and approves CDM and JI project methodologies proposed by individual projects and developers. This approval process can be timely and stringent in order to ensure that only high quality offset credits are generated for use. Approved methodologies generally fall into one of the following categories: reducing emissions from energy production, increasing industrial efficiency, methane destruction, or reducing non-combustion GHG emissions. Several approved project methodologies reduce emissions in the transportation sector; however, no methodologies in the aviation sector that directly reduce emissions and meet the financial and permanence criteria of the CDM have been approved at this time. Offset credits from United States projects are not eligible to supply Kyoto markets because the United States did not ratify the Kyoto Protocol.

The UNFCCC as well as other less inclusive conventions occur regularly to discuss global climate change and strategies to reduce emissions. Conversations of late have focused on global carbon commitments and reduction strategies post-Kyoto (post 2012). No specific plan has been set to date and conversations are ongoing. At this time, the aviation sector is not directly covered by carbon markets, although Europe has a definitive timeline for including the sector under its trading scheme. However, indirectly the aviation sector can be impacted by rising fuel costs to cover compliance costs. Opportunities for airport sponsors to participate in the carbon offset credit market by hosting or sponsoring projects exist but have not been widely undertaken to date. Key policies and carbon markets, as well as the treatment of the aviation sector, are discussed herein at both the regional and national levels.

4.1.1 European Union

Key Takeaways for Airports

- Europe's carbon trading scheme represents the most mature carbon market globally and can be viewed as a precedent of what others might look like in the future.
- 2012 and beyond, emissions from aircraft taking off or landing in Europe will be regulated under the EU ETS.
- Emissions from airports themselves will not be regulated.

The European Union Emission Trading System (EU ETS) is the world's first and largest binding international trading system for CO_2 emissions. It covers over 11,000 energy-intensive installations across Europe and serves as an integrated emission trading system designed to reduce GHG emissions across Europe. The program requires installations to procure European Union Emissions Allowances (EUAs) for every tonne of CO_2e that they emitted the previous year.

The EU ETS officially commenced in January 2005 with 15 member states and was designed to operate in three phases. The initial phase of the EU ETS spanned from 2005 to 2007. The program is currently in Phase II, which began in 2008 and continues through the end of 2012, concurrent with the Kyoto timeframe. Only the electric generation sector and selected large industrial sectors are covered at this time.

Phase III will begin in 2013 and is likely to shift away from emission caps set nationally and toward a more centralized system in which the majority of the allowances are auctioned by a central EU authority. A number of new industrial sectors are likely to be brought under the compliance regime in Phase III but will be freely allocated a portion of their emission allowances. Ultimately, EU leaders have committed to reducing total EU GHG emissions 20% below 1990 levels by 2020, and the Phase III emissions caps are likely to ensure compliance with this target.

The aviation sector will, for the first time, be covered under the EU ETS in 2012. The EU ETS is the only carbon trading scheme to date that has or is planning to hold the aviation sector responsible for their GHG emissions. Airlines will be required to surrender one EUA or eligible offset credits for every tonne of GHG emissions released from a domestic or international flight that either originates or lands at an airport of a participating country. This means that flights originating in the United States and landing in one of the EU-27 nations will be impacted by this regulation. Certain flights, including military operations, search and rescue flights, training flights, and those by aircraft weighing less than 5,700 kg are exempted from the program. Emissions include the first movement of an aircraft from departure location to its final resting after landing. The aviation sector will receive a relatively large pool of free emission allowances initially to help mitigate the cost of compliance. In 2012, airlines will receive free emission allowances that will cover approximately 97% of baseline emissions, determined as the average annual emissions released from 2004 to 2006 (Flight Global 2011). This allocation will decrease to 95% for the duration of the following compliance period beginning in 2013, and will continually decline thereafter. Because the pool of potentially covered entities will vary, airlines will have to apply to the EU in advance of the compliance period to be considered to receive allocations under the EU ETS.

Airlines must undertake a number of steps to comply with EU ETS. First, they must obtain an EU ETS GHG permit to operate in the EU. Additionally, airlines will be required to develop a plan for accounting for, monitoring, and verifying GHG emissions and to have implemented this to account for calendar year 2010 emissions as an initial baseline year. The plan for tracking and reporting emissions is documented in the GHG permit. Annual emissions must be independently verified and reported to the EU by April following the close of the calendar year. Allowances to cover these emissions, which may include EUAs, CERs (up to 15% emissions), or other approved flexibility mechanism units, must be surrendered by May 2013 and annually thereafter for the previous calendar year emissions. Finally, projected CO_2 emissions covered under the EU ETS must be incorporated into corporate planning and public financial information.

The impact to passenger costs and airline revenues is expected to be noticeable, but not significant enough to deter ridership significantly in the near term due to the large allocation of free emission allowances. The EU estimates that individual ticket prices will increase by approximately €2–€9 through 2020 (European Commission n.d.). However, the full impact of the market-based mechanism is not fully quantifiable at this time. Further, at this time there are several United States airlines that have launched litigation against the EU for these regulations. This case is in the hands of the European Court of Justice. Until a final decision would be made to except these entities, the airlines must comply with the rules as written (European Commission 2011).

At this time no other national carbon regulation is slated to cover airline emissions. However, due to the global nature of the industry, the EU ETS may set a precedent for other national or regional climate trading schemes to also directly cover the aviation industry.

4.1.2 New Zealand

The New Zealand Emission Trading System (NZ ETS) was passed in 2008 and implemented in July 2010, and after the EU ETS, represents the second most developed national level cap-and-trade program in the world. Currently, forestry, transportation fuels, electricity producers, and industrials are covered. By 2015, synthetic gas producers, the waste sector, and agriculture will fall under coverage of the NZ ETS. New Zealand Units (NZUs) may not be traded to another nation for compliance purposes. Participants in the NZ ETS will retain the ability to use Kyoto flexibility mechanism credits for compliance purposes with no limits, providing a solid linkage to the global carbon market.

At this time the aviation sector is not directly covered under the NZ ETS. However, impacts are expected from indirect cost pass through from the transportation fuels sector.

4.1.3 Other Developed Economies

Other developed nations, such as Australia, Canada, and Japan, that have committed to the Kyoto Protocol have yet to finalize national plans for compliance. Iceland has chosen to participate in the EU ETS to meet its national Kyoto commitments. Much discussion has occurred at the national level in these countries to implement national trading schemes linked to the global carbon market but have yet to be finalized and implemented. A major argument preventing greater participation in the global carbon market is the lack of participation to date of the world's leading emitters, the United States, China, and India.

4.1.4 Developing and Emerging Economies

No other countries at this time have fully implemented national carbon regimes. Developing and emerging economies have resisted setting a hard cap on carbon due to fears that this cap will inhibit their economic growth. A common means for these countries to address their contributions to global emissions is through the adoption of intensity-based GHG emission targets. Intensity-based targets can use any number of established baselines—including emission reductions over a "business as usual" emission trajectory or reducing emissions per unit GDP—ensuring continued economic growth. Coming out of the UNFCCC conference of 2009 in Copenhagen, Denmark, several emerging economies with intentions to address their emissions, including China, Brazil, India, Indonesia, South Korea, and South Africa, agreed to develop plans around intensity-based targets. Many of these countries are still developing national plans to meet these intensity-based targets. At this time, there is no definitive impact to the aviation industry from these commitments. For the next few years, at least until the end of the first Kyoto commitment period in 2012, these nations will continue to be eligible host countries for CDM projects until a succeeding program is designed and implemented for the post Kyoto period.

CHAPTER 5

Renewable Energy and Associated Markets

Table 8 presents some of the instruments presented in this chapter.

5.1 Renewable Energy Certificates

Key Takeaways for Airports

- The tradable certificate associated with renewable energy is a Renewable Energy Certificate (REC).
- RECs present more opportunities to airports than offset credits at this time.
- To date, solar is the most commonly used renewable technology at airports.
- To avoid the administrative challenges of REC certification and of transacting a REC sale, airport sponsors may prefer to avoid retaining REC-rights as part of a power-purchase agreement.

Promoting renewable electricity generation is often cited as a critical part of reducing the concentration of GHGs in the atmosphere, as renewable electricity generation is considered a carbon emission free source of electricity. Renewable electricity refers to generation from a renewable resource. The definition of renewable can vary, particularly when being defined by policy makers. However, at a minimum, the definition usually includes solar, wind, biomass, landfill gas, hydroelectric, and geothermal sources. Most of the world's electricity still comes from combusting fossil fuels. According to the U.S. Energy Information Administration, over two-thirds of the world's electricity supply in 2007 was sourced from fossil fuels as shown in Figure 6.

Some airport sponsors have installed renewable energy sources to generate electricity to power airport operations and limit the amount of power they purchase from their local utility or other power provider. To date, solar has been the most common renewable technology installed at airports.

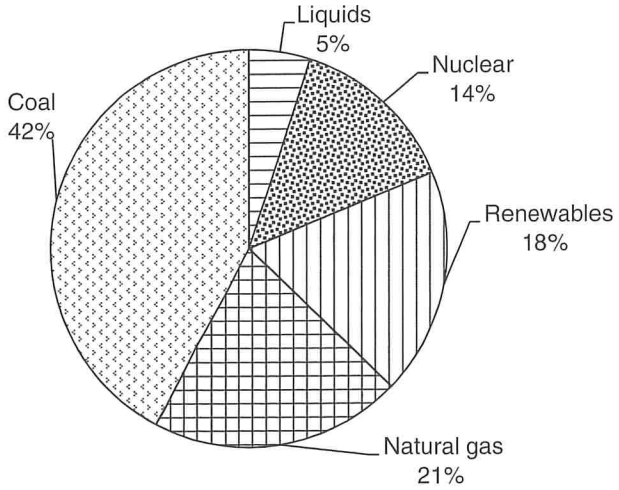
A number of financial support mechanisms have been designed to promote renewable electricity. Government subsidies, tax breaks, and loan guarantees are often implemented by governmental bodies to promote renewable energy development within their borders. The "green value" of renewable electricity is also bought and sold in a marketplace. The popular market-based system uses tradable certificates in order to facilitate transactions between renewable electricity generators and interested consumers who cannot economically generate the renewables themselves. Often referred to as RECs, these tradable commodities represent proof that one unit of electricity (usually a megawatt hour "MWh" or kilowatt hour "kWh") was generated from a recognized renewable source.

Table 8. Instruments referred to in Chapter 5.

Instrument	Description
Renewable Energy Credits (RECs)	Tradable instruments that represent proof that one unit of electricity was generated from a renewable energy resource. Units are usually in MWhs or kWhs.
Energy Efficiency Credits (EECs) / White Tags	An instrument that represents proof that one unit of electricity was saved.
Demand Side Management (DSM)	Programs where large energy users agree to curtail their energy consumption during times of peak energy demand, usually in exchange for some form of compensation or lower rates from their electric utilities.
Airport Emission Reduction Credits (AERCs)	Credits issued to airports for reducing criteria air pollutants.

The need for RECs stems directly from the nature of electricity grids. Specifically, it is virtually impossible to ensure that an electron generated from one source, transmitted through the electricity grid, can be delivered to a specific end-user. The challenge in tracking electricity is analogous to pouring a bucket of water in a swimming pool and then draw a bucket of water out the other end—there is no easy way to know whether the water in the second bucket contained water molecules from the first.

RECs create a means to track renewable energy ownership on a contractual basis, allowing the owner of the REC to claim the renewable attributes of that power. Sometimes end users will contract for power and RECs in what is known as a bundled transaction. Other times, the end-user may not need to purchase additional power, but would like the power that it is currently consuming to be considered renewable. In these instances, the end-user may simply purchase the RECs. Figure 7 is a schematic of renewable generation and REC creation.



Note: This edition of the *International Energy Outlook* presents historical data through 2007.
Source: USEIA. *International Energy Outlook 2010.* Washington, D.C., U.S. Energy Information Administration, 2010.

Figure 6. World electricity supply by source.

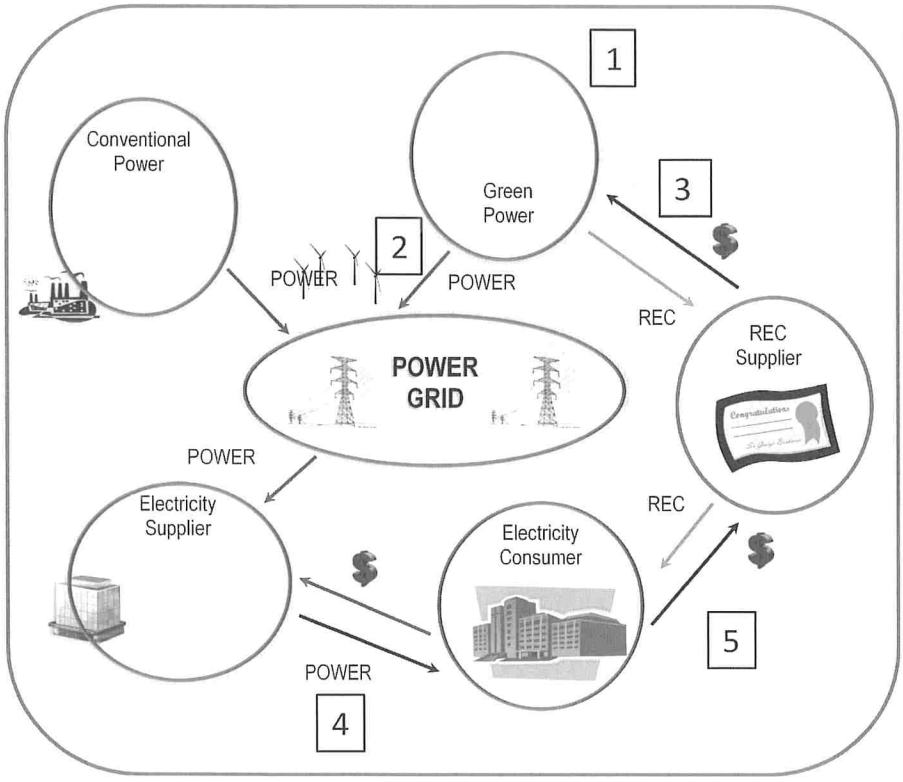


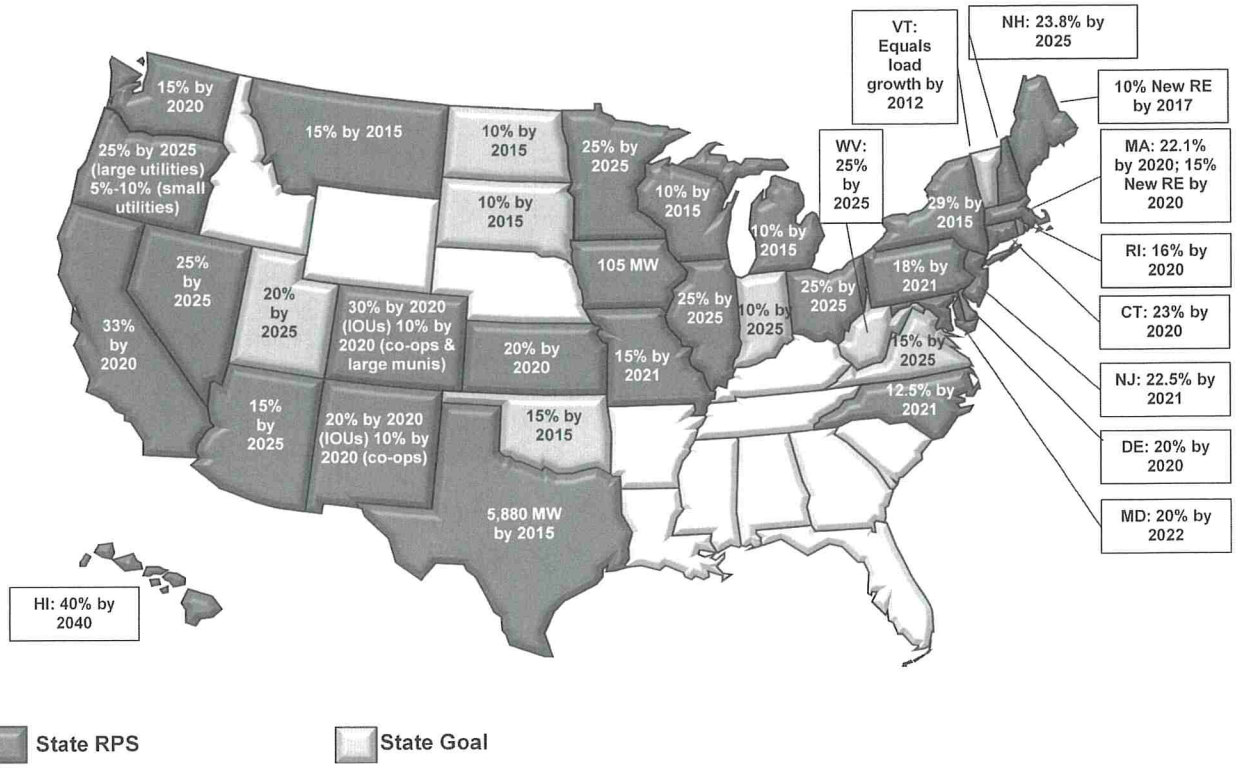
Figure 7. Consuming renewable electricity.

5.2 REC Markets

Both mandatory and voluntary markets for RECs exist. Potential purchasers include entities that wish to act as good environmental stewards or to improve their branding by claiming that the electricity they consume is sourced from a renewable energy resource. Other purchasers might be suppliers of electricity, who are required by law to source a certain percentage of their total electricity load from renewable energy resources. For these REC purchasers, obtaining RECs through third party renewable generators may be a lower cost option compared to building and generating their own renewable electricity. Renewable energy developers benefit from this type of program, as RECs represent an additional revenue stream that may be critical in securing financing necessary to build a new project.

RECs, like carbon offset credits, can represent a GHG reduction. For instance, one MWh of electricity generated from a renewable source likely has lower emissions associated with it than that of coal-fired generation. Renewable generation can take the place of higher emitting electric sources and help to reduce overall GHG emissions. However, United States–based offset protocols at this time do not recognize renewable energy projects as carbon reduction projects for the purposes of issuing carbon offset credits. Therefore, in the United States, renewable energy projects are not usually considered carbon offset projects and there is virtually no market for carbon offset credits from renewable energy. Almost universally, RECs are the tradable certificates used in the United States to represent the environmental attributes of renewable electricity.

As with offset credits, opportunities to transact RECs exist in both voluntary and compliance markets. Tradable REC programs are often established as part of Renewable Portfolio Standards (RPSs) or Renewable Electricity Standards (RES). No comprehensive national RPS/RES exists in the United States at this time, although activity in Congress suggests that some support exists for such an initiative. Even without a federal standard in place, 30 states and the District of Columbia have enacted mandatory state-level RPS requirements as shown in Figure 8; numerous state goals and city and regional level RPS programs also exist.



Source: DOE. *U.S. Department of Energy - Energy Efficiency & Renewable Energy.* http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm (accessed May 15, 2011).

Figure 8. Summary of state-level RPS programs in the United States.

Each of the state-level RPSs dictates different targets, eligible renewable technologies, compliance dates, geographic restrictions of supply, and bundling requirements among other provisions. The variation in state requirements results in a patchwork of compliance requirements and cost levels for compliance.

Along with the mandatory REC market created by state-level RPS programs, there is a voluntary market for RECs in the United States. The voluntary market is characterized by similar elements as the voluntary offset market and is largely driven by entities wishing to act as good environmental stewards by making renewable claims to their energy. Many retail chains tout that their stores consume renewable electricity, for example some major retailers proclaim that their stores are "100% wind-powered." In these instances, it is unlikely that all of the electrons being consumed by the store were actually generated from a wind farm. The electricity grid is a combination of electrons from all electricity sources feeding it, determining or directing certain electrons to go to one consumer and not another is a physical impossibility. By purchasing RECs, the store is buying the renewable attributes of generation and the right to claim that they are consuming power from wind or another renewable source.

REC tracking systems have been established as a means for issuing, tracking, and trading RECs. At this time, tracking systems are largely regional. Many state RPSs utilize these tracking systems and often require transactions to take place through these systems. The tracking systems can overlap in some states, but states with RPSs generally use one of the eight REC tracking systems shown in Table 9. Tracking systems vary in the fees that they charge renewable generators. Depending on the tracking system, an airport might be required to pay fees for initial registration, annual subscription, and REC issuance. Often the fees within a tracking system will vary based on the size of the renewable system being registered.

Table 9. REC tracking systems.

REC Tracking System	Commonly Used Acronym	U.S. States covered	Fees for Renewable Generators
Electric Reliability Council of Texas	ERCOT	TX	Annual: NA Registration: NA Issuance: NA
Midwest Renewable Energy Tracking System	MRETS	MT, ND, SD, MN, WI, IA, IL, OH	Annual: $500/yr Registration: NA Issuance: $0.005
North American Renewables Registry	NAR	MO (NAR allows generators anywhere in North America to register projects. Designed in part to serve states not covered by other tracking systems)	Annual: $50–$2,000/yr Registration: $50–$1,000 Issuance: $0.05/REC
Michigan Renewable Energy Certification System	MIRECS	MI	Annual: $100–$1,500/yr Registration: $50–$750 Issuance: NA
New England Power Pool Generation Information System	NEPOOL-GIS	ME, VT, NH, MA, CT, RI	Annual: NA Registration: NA Issuance: NA
North Carolina Renewable Tracking System	NC-RETS	NC	Annual: NA Registration: NA Issuance: NA
Pennsylvania, Jersey, Maryland Power Pool Generation Attribute Tracking System	PJM-GATS	PA, NJ, DE, MD, VA, WV, OH, IN, IL	Annual: $1,000/yr Registration: NA Issuance: NA
Western Renewable Energy Generation Information System	WREGIS	CA, OR, WA, ID, NV, AZ, UT, MT, WY, CO, NM, SD	Annual: $200–$1,500/yr Registration: NA Issuance: $0.005/REC

By nature, REC markets are typically confined to those in the energy business. For this reason, airport sponsors have played a minimal role in selling RECs, which are outside of the core business of airport management. In most historical examples of on-site airport renewables, the airport sponsor relies on a "power-purchase agreement" (PPA)—a legal arrangement in which a specialized company owns and operates the renewable power system and the system is dedicated to generating electricity for the airport sponsor to purchase. Typically, the specialized company (often called a "solar services provider" receives the rights to the RECs as part of the PPA. Thus their only demand for RECs would be in the voluntary market. Airports are starting to install renewable energy facilities on site. Some are supplying REC markets and others are retaining the RECs to claim the environmental benefits from renewable generation for the airport itself.

Airports must consider a number of factors when deciding whether or not to install a renewable energy project on-site. Table 10 presents potential renewable technologies for airports, a general description of the technology, and some important factors that airports should consider.

Table 10. Renewable technologies and airport applications.

Technology	General Considerations	Airport Considerations
Solar	• Derived from the sun through the form of solar radiation. • Different technologies convert solar power differently - Photovoltaics (PV) generate electric power by converting solar radiation into direct current electricity using semiconductors. - Other solar technologies capture the thermal energy (heat) from the sun to generate electricity or provide heat. • Geographic location and other climate factors impact the amount of power a given solar project can generate. • In some jurisdictions, the value of a solar REC is substantially higher than that of other renewable technologies.	• PV represents the most likely solar technology for airport roofs and/or lands. • On a $/unit of energy basis it is often more expensive than other forms of renewable energy; however, it is also one of the most applicable current technologies for airports. • Represents currently the most popular form of renewable projects for airports. • "Technical Guidance for Evaluating Selected Solar Technologies on Airports" was published by the FAA in November 2010. This document provides detailed siting, operational, and financial considerations for airport operators evaluating PV at their airport. • Installation of PV at airports may improve air quality and is eligible for FAA VALE funding in air quality non-attainment areas if the applicable air agency allows the issuance of AERCs. This funding can result in a significantly reduced payback (in some cases as little as five years).
Wind	• Converts wind energy into electricity using wind turbines. • Geographic location and physical features of site impact the amount of power a given project can generate.	• Traditional horizontal axis wind turbines represent a challenge for airports as impediments to air space. • Vertical axis wind turbines on terminals and other structures may present a more viable wind option, but are often less efficient.
Geothermal	• Utilizes the geothermal energy contained in the earth's core to generate electricity. • Geothermal reservoirs are often deep underground, not accessible everywhere. • Ground sourced heating and cooling does not require geothermal reservoirs.	• Distributed geothermal or geothermal heat pumps used for building heating and cooling and for hot water heating.
Hydropower	• One of the oldest and most widely used forms of renewable power. • Uses the gravitational force behind falling or flowing water to generate electricity. • New technologies are gaining some prominence, including pumped-storage and tidal power.	• Requires access to a flowing source of water to produce electricity.
Biomass	• Generally involves combusting biomass material from living or recently living organisms such as wood, waste, and alcohol fuels. • Definitions of what constitutes biomass can vary widely	• Sufficient biomass feedstock can be a challenge depending on where airports are located. Biomass sources generally need to be located in close proximity to the end user.

Case Study 3 examines the solar project hosted at the Meadows Field Airport in Bakersfield, CA. The County of Kern, which owns and operates the airport, is eligible to retain the RECs associated with the project as part of the contract with the solar system provider. The case study examines the potential revenue opportunities for the County, should they elect to sell the RECs associated with the project.

Case Study 3: Meadows Field Airport, Bakersfield, CA

The County of Kern, California, owns and operates Meadows Field Airport, a non-hub airport situated in the County's largest city, Bakersfield. In 2008, the County entered into a Power Purchase Agreement (PPA) with a solar services provider, Regenesis Solar Power. The PPA enabled Regenesis to install a 744 kW, on-airport solar PV system designed to provide about 75% of the power required by Meadows Field Airport's main facility, the William M. Thomas Terminal. In general, the County's PPA is similar to most airport PPAs nationwide. The primary provisions of the PPA are that (1) the County agrees to purchase power from the PV system for 20 years beginning at $0.125/kWh, with a 2.9% annual multiplier (i.e., increasing to $0.221/kWh in year 20) and (2) Regenesis agrees to operate and maintain the PV system. In other respects, the County's PPA is unique when compared to historical practices at other airports. Specifically, the County retains the rights to half of the "green" power attributes and, therefore, also to half of any RECs generated by the facility.

By retaining the rights to green power attributes, the County has the option to: (1) pursue REC certification and sell the RECs in a suitable market or (2) avoid the cost of REC certification and retain the "green claims" associated with the solar generation. If the County so wishes, they can publicize the achievement of greenhouse gas reductions and sustainable energy sourcing as a result of airport investments. This would not require a certification or retirement process for the RECs. According to Regenesis, the solar PV system reduces greenhouse gas emissions by 2,000 tonnes per year versus what the airport would otherwise consume from grid power—equivalent to removing about 175 automobiles from the road.

The State of California has a Renewable Portfolio Standard (RPS), and historically the RPS regulations (California Energy Commission, January 2008) have not permitted "distributed generation" systems like the Meadows Field solar PV system (and virtually all airport PV systems installed nationwide) to qualify for RPS requirements. As a result, RECs generated by a typical California airport's solar PV system would only have been suitable for sale on the voluntary national REC markets. Voluntary markets currently yield an estimated $1.00 per megawatt-hour for RECs, which translates to around $1,600 per year in the Meadows Field example. It is possible that a buyer on the voluntary market of solar RECs (as opposed to a generic renewable mix) would pay a premium for the Meadows Field solar RECs. Recently, California amended their RPS rules, allowing for more flexibility in the way RECs (referred to as TRECs for tradable renewable energy credits) can be applied for compliance. One potential change being considered by the California Energy Commission (CEC) is allowing distributed generation solar systems, like the Bakersfield system, to qualify for RPS compliance. If such a decision is made, the RECs from the Bakersfield project would have substantially more value. In such a scenario, at pricing

(continued on next page)

Case Study 3: (Continued).

between $10–$20 per megawatt-hour, the Bakersfield RECs could earn between $16,000–$32,000 per year. It should be noted that at this time there is not much price transparency for California TRECs and these prices are merely hypothetical.

The typical solar services provider that operates and maintains an airport solar PV system likely has the expertise—or easy access to it—to efficiently execute a REC transaction in the voluntary markets. Accordingly, airports that are not using RECs to make green claims may, depending on the state in which the airport is located, prefer to structure a PPA such that the solar services provider retains the rights to RECs. By doing so, an airport may (1) avoid the administrative efforts of certification and of transacting a REC sale and (2) receive a lower price for power via the PPA.

The PV system at Meadows Field also affords the opportunity for the County to sell excess electricity to the regional utility provider, Pacific Gas and Electric (PG&E). By law in California, and in many other states, the "net-metering" policy incentivizes the installation of small, localized renewable electricity generation systems (DSIRE, 2011). Net-metering policies require that the regional utility provider purchase excess electricity generated by localized renewable systems, wherein excess electricity is defined as the difference between what the renewable system produces and the electricity demand of the connected onsite facility—which in the case of Meadows Field is the William M. Thomas Terminal. The value of excess electricity sold to PG&E is credited back to the County on an annual basis.

The value of the PPA to the County and Regenesis is further strengthened by (1) a federal tax incentive for solar photovoltaics owned by private corporations (in this case Regenesis) and (2) a California incentive program for renewable power production called the "California Solar Initiative" (CSI), which at its inception provided an incentive of $0.35 per kWh over 5 years and which, as the program reaches its completion, will provide $0.03 per kWh. The reason for the declining incentive is that the solar PV market is expected to eventually sustain itself. The PV system was receiving from CSI a Step 4 incentive of $0.26/kWh as of July, 2011.

5.2.1 Energy Efficiency Credits "White Tags"

Numerous states have Energy Efficiency Portfolio Standards (EEPS) that place a mandate on regulated utilities to achieve certain levels of improved energy efficiency by their end-use customers. Utilities meet these obligations by incentivizing their customers to implement various energy efficiency or conservation measures (rebates for installing energy efficiency appliances, higher efficiency HVAC equipment, etc.) Often, EEPSs permit trading between utilities through EECs or "white tags," whereby a utility with white tags in excess of the mandated levels can sell to other utilities that may have a shortfall.

White tags are a measure and calculation of actual power saved through the direct result of a conservation or energy efficiency action. They represent actual energy saved, as opposed to RECs which represent energy generated. White tags should also be distinguished from demand side management (DSM) programs, which generally involve utilities providing incentives to large energy users for curtailing their energy consumption during times of peak energy demand.

While EEPS create a compliance market in many states, there is also a voluntary market where large corporations are beginning to purchase white tags as part of broader initiatives to reduce their carbon footprint.

Airports have invested in numerous energy efficiency projects; however to date they have not been major participants in white tag markets. Case Study 4 examines a unique example of an airport creating and selling offset credits from an energy efficiency project. The Montreal Airport

Case Study 4: Montreal Pierre-Elliot-Trudeau International Airport, Dorval, Canada

The Montréal Pierre-Elliot-Trudeau International Airport in Dorval, Canada, is the third busiest airport in Canada. The airport is located 12 miles west of Montreal. In 2010 the airport served close to 13 million passengers.

In 2001, Aéroports de Montréal (ADM), a not-for-profit corporation responsible for the management, operation, and development of Montreal-Trudeau Airport, undertook a significant energy efficiency project to modernize the airport's central heating plant. The project's scope included relocating the off-site heating plant inside the terminal as well as installing high efficiency bi-fuel boilers, chillers with heat recovery condensers, and direct contact energy recovery equipment. Relocating the heating plant enabled improved energy efficiency and allowed for an expansion of the HVAC system. In addition to the reduced operational energy costs resulting from the project, the associated GHG emission reduction from this project allowed ADM to realize a revenue stream through the sale of voluntary carbon credits.

Carbon credits from this project were calculated through the difference in CO_2e emitted from the old heating plant compared to the new, more efficient heating plant. ADM completed its first transaction of carbon credits in 2009, selling 24,200 carbon credits (accrued between 2004 and 2009) on the Canadian voluntary carbon market) for a price of CAN$5/t$CO_2e$. This equated to an annual revenue stream of about CAN$20,000 over 6 years. ADM required a third party to verify the GHG emission reductions on their behalf. Another third party prepared the quantification report and originally bought the carbon credits after registering the credits with the Canadian Standards Association. All 2004–2009 credits were ultimately sold to The Greening Canada Fund who retired the credits. The Greening Canada Fund is a voluntary carbon emission reduction fund aimed at achieving environmental benefits through the financial support of large Canadian corporations who wish to reduce their "carbon footprint." According to ADM, the sale of carbon credits was positive overall and elicited goodwill from the community and airport industry. In the future, ADM will perform the quantification, verification, and sale of carbon credits every 3 years as opposed to on an annual basis in order to reduce administration and transaction costs.

Between 2008 and 2009, the total carbon emission reduction resulting from the energy efficiency project was 6,500 tonnes. This is the equivalent to removing nearly 565 automobiles from the road every year (ES EPA, 2000). Going forward, assuming the same carbon emission reduction as 2008–2009, ADM has the potential to raise on average more than CAN$32,500 annually through this source if the

(continued on next page)

Case Study 4: (Continued).

price for voluntary credits stays at CAN$5/$tCO_2e$. The spread in recent years for carbon credits from efficiency projects is between CAN$3.9/$tCO_2e$ and CAN$6.9/$tCO_2e$ (EcoSystem 2009). However, the lack of a mandatory carbon market in Canada presents uncertainty for any airport operator selling credits on the voluntary market as it is more illiquid than a standard exchange market or over-the-counter market where demand is high. The spread in recent years for carbon credits from efficiency projects is between CAN$3.9/$tCO_2e$ and CAN$6.9/$tCO_2e$ (EcoSystem 2009). There even exists the chance that buyers for voluntary credits will not be available immediately when the operator wishes to sell.

This case study is included as it is the only known example of an airport in North America monetizing carbon offset credits. While two of the three major United States–based offset standard bodies, the Climate Action Reserve and the American Carbon Registry, do not recognize energy efficiency measures—which this example illustrates—as eligible carbon offset project types, the Voluntary Carbon Standard accepts such offset project types. With that said, having a carbon reduction project recognized by a major offset standard body is not a prerequisite for monetization. However, buyers in the voluntary market may prefer offsets to have been created or approved by certain offset bodies over others.

project is the only known example of an airport in North America monetizing carbon offset credits. Many United States–based offset standard bodies do not recognize energy efficiency measures as eligible carbon offset project types. Of course, having a carbon reduction project recognized by a major offset standard body is not a prerequisite for monetization. With that said, buyers in the market may prefer that offset credits be created or approved by certain offset standards bodies over others.

5.3 Voluntary Airport Low Emission Program (VALE)

Key Takeaways for Airports

- Airport Emission Reduction Credits (AERCs) from the VALE program represent reductions in criteria pollutants, which are non-GHG air pollutants that directly affect human health.
- AERCs are similar to offset credits: reducing air pollutant emissions from one activity to account for increased emissions from a different activity.
- Unlike offset credits, AERCs cannot be traded; therefore airport sponsors should avoid trading RECs that implicitly include AERCs.

The use of credits associated with environmental initiatives and emission reduction projects is not a new concept for airports. Under the Federal Aviation Administration's (FAA's) Voluntary Airport Low Emission (VALE) program, airports are eligible to receive airport emission reduction credits (AERCs) for projects that reduce emissions of criteria air pollutants (which does

not currently include GHGs). The emission savings, represented by the AERCs, can later be applied to a conformity evaluation or determination for future projects or air service additions that increase an airport's overall emissions.

5.3.1 VALE Program Description

In 2003, the *Vision 100—Century of Aviation Reauthorization Act (Public Law 108-176),* established the VALE program to encourage airports to voluntarily reduce emissions from aircraft, vehicles, ground support equipment (GSE), and infrastructure at commercial service airports in areas designated as nonattainment and/or maintenance by the EPA's National Ambient Air Quality Standards (NAAQS) (Public Law n.d.). This FAA program is intended to reduce pollutants and precursors, improve local air quality, and accelerate the use of new and cleaner technology.

Examples of previously funded projects include clean technology for boilers, vehicles, electric GSE, natural gas refueling stations, gate electrification, and alternative energy systems including geothermal and solar photovoltaics (PV).

Program benefits include the following:

- Provides funding for clean airport technology,
- Removes regulatory barriers with emissions credits,
- Encourages use of domestic alternative fuels,
- Encourages early pollutant mitigation measures,
- Reduces airport and airline fuel and maintenance costs,
- Expedites the environmental review process for airport modernization,
- Establishes airport commitment to environmental stewardship,
- Useful for public relations, and
- Initiates dialog between airport and air quality agencies.

The FAA funds VALE projects through the AIP. Airports can also use local funds through the use of Passenger Facility Charges (PFCs). AIP funding is 75% for medium-to-large hub airports and 95% for smaller commercial service airports. PFC funding can cover up to 100% of eligible costs.

As part of the VALE program, the FAA has funded 40 low-emission projects at 22 airports, which represent a total investment of $83 million in federal grants and $25 million in local airport matching funds. These projects have resulted in a reduction of 5,500 tons of ozone emissions, which represents the equivalent of removing 13,500 cars and trucks off the road every year for the next 10 years (FAA 2010a).

5.3.2 RECs and AERCs

Key Takeaways for Airports

- Provided that an airport sponsor retains all AERCs, the sponsor of a VALE-funded renewable energy project may be able to earn revenue from the renewable attributes of the project by selling RECs.

The VALE program is intended to reduce criteria pollutants and as a result also reduces GHGs. However, there is currently no structure in the VALE program to provide credits for GHGs. As GHG regulations progress, VALE could provide the framework for crediting airports with GHG AERCs or other similar instruments.

New, on-site renewable energy sources funded by VALE create an opportunity to generate both RECs and AERCs for airports. Per VALE program rules, the airport operator is not allowed to sell the AERCs associated with that power generation; however, the airport operator can elect whether to retain or, provided that certain conditions are met, sell the RECs. The primary condition is that the REC sale does not include the sale of the AERCs. In other words, the REC must not include the criteria pollutant emission reductions, which are the basis of the AERCs for on-airport use. This requirement should be considered as airport operators plan how they will use the RECs and AERCs associated with renewable generation. Furthermore, as a means of ensuring proper use of airport revenues, FAA has previously required that sponsors of VALE-funded renewable energy projects commit—should the sponsor choose to sell the RECs associated with the project—that the sponsor would only receive discounts from the local utility provider rather than conduct a sale on the wider REC market (FAA 2010b). Another consideration is that the FAA rules on AERCs may even preclude the sale of RECs in some mandatory markets that define RECs to include "all environmental attributes."

CHAPTER 6

Trading Offset Credits and RECs

6.1 Implications of Retiring and Trading Environmental Instruments

Key Takeaways for Airports

- An airport that sells its offset credits or RECs loses the ability to claim the environmental attributes of that power.
- Airports must weigh the value associated with being an environmental steward against the monetary value from selling offset credits or RECs.

As was discussed earlier in the *Primer,* there are two primary sources of value that can be created for airport operators by hosting carbon offset and renewable energy projects. The first is monetary—developers of projects can sell the environmental benefits of their projects in the form of offset credits or RECs. The second is reputational value—an entity that wishes to reduce their carbon footprint or comply with an environmental regulation can retain the environmental benefits from a project by retiring the credit. Generally a credit is retired through whatever standard body, regulatory body, or tracking system issued it in the first place. The act of retiring a credit effectively locks in the environmental attributes to the person or entity that elected to retire the credit.

However, if an airport project host elects to sell the associated credits, the airport sponsor loses the ability to claim the environmental attributes of that project. This can be a difficult idea to conceptualize and it is worth considering the following example:

If an airport operator installs solar panels at its facility to generate electricity to serve the airport, and sells the RECs associated with it, they cannot claim that their airport is being powered by solar energy. Even though the electricity the airport is consuming came from a solar panel, the definition of a REC encompasses all of the environmental attributes of the renewable energy. In the eyes of the environmental market, they are consuming non-renewable power. If an airport was, at least in part, motivated to host a renewable energy or offset project to reduce their carbon footprint, then careful consideration should be made before selling the environmental attributes of that project in the form of an offset credit or REC.

The decision to sell RECs in order to create additional revenue streams must be balanced against the benefits of consuming renewable or "green" power. The value of the REC can vary significantly based on the market into which it is being sold, ranging from approximately $1 to $40/MWh for traditional RECs. Solar RECs can be priced as high as $600/MWh in select markets.

Similar considerations should be made with offset credits. Offset credits represent one tonne of CO_2e avoided. If an airport sponsors an offset project to lower their own carbon footprint, they must retain and retire that offset credit. Selling the offset credit gives credit from the reduction achieved by the project to the purchaser of the offset credit.

6.2 Overview of Carbon and Environmental Instrument Trading

Key Takeaways for Airports

- Airport owners and managers need to identify potential avenues for selling their offset credits and RECs.
- Entering into a bilateral contract with a REC or offset credit purchaser can provide an airport with a fixed or guaranteed revenue stream.

If the decision is made to sell environmental credits associated with a project, several options exist for doing so. The prominent methods to trade environmental instruments are:

- Exchanges,
- Wholesale brokers,
- Retail brokers, and
- Bi-lateral transactions.

The optimal means to transact the environmental credits will largely hinge on (1) the total volume of credits to be sold, (2) the type of environmental instrument (i.e., offset credit, REC, white tag, etc.) and (3) the presence or absence of a known buyer (typically called an "off taker"). There is no minimum transaction volume per se, but the economic benefits of monetizing should be weighed against transaction costs. Table 11 presents a summary of the applicability of different paths to sell environmental instruments. This table should be interpreted as "rules of thumb," noting that every project has unique characteristics that may not directly align with these recommendations.

Table 11. Best uses of environmental instrument transaction methods.

Transaction Method	Best Use	Pros	Cons
Exchange	Large transaction volumes of commonly traded instruments (greater than 1,000 carbon offset credits or 100 RECs)	Low per unit cost to transact for large volumes, efficient	Does not support volumes less than 1,000 carbon offset credits or 100 RECs
Wholesale Broker	Moderate to large volumes of a wide variety of environmental instruments	Customized transaction support at moderate cost	Not an option for small volumes (less than 1,000 carbon offset credits or RECs)
Retail Broker	Small volumes (less than 1,000 carbon offset credits or RECs)	Option for small volumes	Costly on a "per unit" basis
Bi-lateral (direct)	Off taker pre-defined, any volume or instrument	No transaction fees	May need outside guidance for off taker identification and contract execution

A more detailed overview of the different trading methods, including examples of providers, is presented in the following section.

6.2.1 Exchanges

Exchanges offer efficient, informed, and low-cost platforms for transacting commodities, futures, and derivatives. These electronic platforms have long been used to transact in agriculture, energy, and mineral markets and are increasingly being developed to support environmental markets. Exchanges are electronic platforms that offer market price data and low cost as well as secure transaction services including trading and clearing. The aim is to both increase transparency of market pricing and to increase liquidity in global and regional markets. The two most prominent exchanges generally for commodities and related products in the United States are the New York Mercantile Exchange (NYMEX) and the Intercontinental Exchange (ICE).

Many exchanges have been expanding their market coverage to include environmental markets. The European Climate Exchange (EEX) for example, is largely used to trade carbon instruments associated with the EU ETS, largely EUAs and CERs. The use of exchanges in environmental markets both increases market pricing transparency and liquidity and is anticipated to continue to increase market volumes.

A number of United States–based and global exchanges that may be of interest to airports both for monetization of environmental instruments and to reference for market pricing data are summarized in Table 12. It should be noted that other international exchanges focus on specific regional markets, including Envex that offers REC and pre-compliance carbon trading in Australian markets. The open interest and volumes cleared vary significantly across exchanges and are particularly limited for voluntary market commodities. It is anticipated, however, that as the environmental markets mature, the use of exchanges to sell these instruments will grow.

6.2.2 Wholesale Brokers

Wholesale brokers and brokerage services facilitate bi-lateral environmental market transactions for a fee. Brokers generally do not take title to commodities; rather they link buyers and sellers and also may assist with negotiating terms and conditions of the transaction. Energy transactions have long used broker services and many of the prominent energy brokerage houses are now expanding to serve environmental markets. Broker fees for environmental transactions generally range from 3% to 6% of total transaction cost, although other fee-based services may be offered by individual brokerage houses. This transaction fee would be additional to any additional monitoring and verification costs of carbon offset projects. Wholesale brokers generally work best for larger volume or higher value price trades as they offer a lower cost per unit transacted

Table 12. Summary of prominent environmental market exchanges.

Exchange (Parent Company)	Commodities	Volume Requirements	Additional Comments
Chicago Climate Futures Exchange (ICE)	CAR-CRT, CFI-US, RGGI, compliance RECs for MA, CT and NJ and Green-e eligible voluntary market RECs	1,000 tonnes	Carbon offset credit and REC commodities applicable to airports
GreenX (NYMEX)	EUA, CER, RGGI, CAR offset credits	1,000 tonnes	Carbon offsets applicable to airports

Table 13. Summary of prominent wholesale brokers.

Broker	Commodities (U.S. Based)	Additional Comments
CantorCO_2e	RGGI, all voluntary U.S. carbon, RECs in all U.S. compliance markets, Green-e eligible voluntary market RECs	Carbon offset credit and REC commodities applicable to airports
Evolution Markets	RGGI, all voluntary U.S. carbon, RECs in all U.S. compliance markets, Green-e eligible voluntary market RECs, white tag	Carbon offset credit and REC commodities applicable to airports
Spectron	RGGI, all voluntary U.S. carbon, RECs in all U.S. compliance markets, Green-e eligible voluntary market RECs	Carbon offset credit and REC commodities applicable to airports
TFS Green	RGGI, all voluntary U.S. carbon, RECs in all U.S. compliance markets, Green-e eligible voluntary market RECs	Carbon offset credit and REC commodities applicable to airports

than retail broker services. Given that any airport offset credit holdings are expected to be in relatively low volumes, wholesale broker services may not be ideal for airports.

Wholesale brokers offer more customized transaction support services than exchanges, often accommodating a wider variety of environmental instruments. A limitation of transacting in some more niche environmental markets is that both a buyer and seller are required to transact, which sometimes poses a challenge in less liquid markets Table 13 presents a summary of some of the larger wholesale brokers and environmental markets served.

6.2.3 Retail Brokers

Retail brokers or retail providers of environmental instruments cater to small volume transactions but often have the highest transaction fee on a per unit basis. Unlike wholesale brokers, retail providers will often take ownership of environmental instruments and bear risk of monetization. On the sell side, retail providers will offer small purchase volumes. For example, retail providers offer airline passengers the ability to offset the emissions associated with a plane trip by selling just a few carbon offset credits at a time. Many different retail brokers exist, offering a wide range of market services. Table 14 presents a summary of some of the larger retail brokers and providers.

Table 14. Summary of prominent retail brokers and providers.

Retail Broker / Provider	Commodities	Additional Comments
Atmosclear	VERs, other offset credits	Retail brokers all serve different niche markets and their focuses can change from time to time. It is recommended that several be contacted to find the ideal broker for instrument transaction.
Bonneville Environmental Foundation	Offset credits and RECs	
Carbonfund.org	Offset credits	
Climate Trust	Offset credits	
Native Energy	Offset credits and RECs	
Sterling Planet	Offset credits, RECs, white tags	
Terrapass	Offset credits and RECs	
3Degrees	Offset credits and RECs	

Table 15. Sample contract sources for bilateral transactions.

Instrument	Contract Source(s)
Carbon Offset Credits	Emissions Trading Master Agreement for the EU Scheme, International Emissions Trading Association – Note this template is designed for compliance instruments and would need to be modified for carbon offset credits specific to the transaction at hand. http://www.ieta.org/assets/TradingDocs/uk-1597905-v1-ieta_etma_v3_0_-_master_agreement_and_sched.pdf
RECs	ACORE, Environmental Markets Association and the American Bar Association Master Renewable Energy Certificate Purchase and Sale Agreement http://www.retscreen.net/fichier.php/1611/ABA_EMA_ACORE_Master_RECs_Agreement.pdf

6.2.4 Bilateral Transactions

Finally, if the owner of the environmental instrument directly approaches potential buyers to facilitate a transaction, no middleman or additional support is needed. This essentially eliminates transaction fees. This also, however, places the burden on the seller to find a buyer and an appropriate contract vehicle. Environmental instrument transaction contracts are increasing in standardization and template contracts are available to help lay the groundwork for establishing terms and conditions associated with a bilateral transaction.

Examples of bilateral transactions at an airport project may include selling the offset credits from a project to travelers seeking to offset the emissions associated with their flight or selling RECs from a renewable energy project to commercial tenants seeking to claim that their store is powered from renewable energy. Template contracts that can be used as a base vehicle to facilitate bilateral transactions are publicly available as summarized in Table 15.

6.3 Offtake Demand Drivers

Key Takeaways for Airports

- Airports should consider why a potential buyer is in the market for RECs or offset credits.
- Often, buyers who are required to purchase RECs or offset credits will be willing to pay more for the instruments than those purchasing for purely voluntary reasons.

Potential buyers of offsets credit, RECs and other environmental instruments sourced from projects at or sponsored by airports may be motivated by a number of different drivers, some to meet compliance demand requirements and others to satisfy voluntary initiatives. When monetizing through a wholesaler, retailer, or exchange, the drive of the buyer is somewhat less important. However, it is good to understand general demand drivers for environmental instruments of projects to ensure that the project best addresses the needs of the market. If an airport

Table 16. Summary of demand side entities by project type.

Project Type	Instrument	Compliance Demand	Voluntary Demand
Carbon Offset Project	Carbon Offset Credit	RGGI and California pre-compliance market players	Businesses, institutions, and individuals seeking to reduce their carbon footprint (i.e., "green" companies, schools, or airline passengers)
Renewable – Solar	Solar REC, aka "SREC"	Utilities and energy providers in states with solar tier requirements in RPS	Businesses, institutions, and individuals seeking to claim solar renewable energy consumption
Renewable – Wind, Biomass, Other	REC	Utilities and energy providers in states with an RPS	Businesses, institutions, and individuals seeking to claim renewable energy consumption
Energy Efficiency	White Tag	Utilities and energy providers in states with efficiency requirements in RPS	Businesses, institutions, and individuals seeking to claim lower energy usage and/or reduction of emissions and externalities associated with traditional energy production

operator is looking to bilaterally source an off taker for environmental instruments of a project, then what drives buyer interest is very important and needs to be considered in the selection process. Because there are no specific requirements for voluntary instrument purchases, the characteristics of instruments sought are completely up to the buyer based on what they want to claim. For example, a buyer may want to source instruments locally, so seeking off takers nearby may be a good option.

Table 16 summarizes likely demand side entities, both compliance and voluntary, for different project types.

With the exception of regional compliance programs, the United States carbon market demand is voluntary at this time. Many businesses and institutions are very interested in reducing their carbon footprint and purchasing verified offset credits is one way to do this. Voluntary market demand is largely driven by the story that the buyer wants to convey through their offset credit purchase. Some buyers may be interested in offset credits from a certain project category or from specific geographic location. In some instances, a buyer may be willing to pay a premium for a certain type of offset credit. For example, a tenant in an airport may like to claim that the operations of their business are carbon neutral through the purchase of offset credits from a project on airport property or another location. Regardless of the offset project type and buyer, it is important to ensure the credibility of the offset credit by having it verified in conformance with the requirements of a reputable standard.

A significant demand for voluntary market RECs exists at this time, in addition to compliance market demand. The primary standard for voluntary REC market certification is the Green-e standard. Many utilities source voluntary market RECs to retire on behalf of individual customers opting into their green energy programs. Like carbon offset credits, many corporations and institutions find value in claiming green energy consumption for some or all of their energy use that further stimulates voluntary REC demand. Likewise, some buyers may want to claim a particular renewable energy technology or location and may be willing to pay a premium to purchase specific subsets of RECs to tell this story.

Finally, voluntary demand for white tags exists, largely by entities that want to claim a reduction in GHG footprint. Several different standards exist for validating white tags, but it is important to ensure that these efficiency reductions are verified before selling to the market.

Airport Offset Example: Carbon Kiosks at San Francisco International Airport

In 2009, San Francisco International Airport was the first airport in the United States to introduce a passenger offset program, called Climate Passport, which allows passengers to calculate and reduce the carbon footprint of their air travel by supporting carbon offset projects based in California. Three Climate Passport kiosks are available at the airport after the security checkpoint on both sides of the International Terminal and in Terminal 3. Travelers can also access the Climate Passport through SFO's website at: http://www.sfo.3degreesinc.com. Using the kiosks or the website, travelers can calculate the carbon footprint of their flights to determine the amount of carbon offset credits or Verified Emission Reductions needed to address the GHG impact. 3Degrees is a local San Francisco carbon and renewable energy marketing firm that manages the Climate Passport kiosks. 3Degrees sources carbon offset credits from The Conservation Fund's Garcia River Forest Project and the San Francisco Carbon Fund to reduce GHGs emitted into the atmosphere by an amount equivalent to that passenger's trip. The carbon offset credits for Climate Passport are sourced from projects that result in real, quantifiable, and permanent GHG emission reductions and are third-party verified against the Climate Action Reserve—a rigorous, objective, and transparent standard for offset credits from forestry projects. Climate Passport also allocates $1.50 per tonne of all offset credit sales to the San Francisco Carbon Fund, a city-run fund that invests in GHG reduction projects within San Francisco. The primary airport expense of the Climate Passport system is development of the three kiosks, which cost $190,000 in total.

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Acronyms

AB 32	Assembly Bill 32
ACES	American Clean Energy and Security Act of 2009
ACR	American Carbon Registry
AERC	Airport Emission Reduction Credit
AEUs	Australian Emission Units
AIP	Airport Improvement Program
ARB	California Air Resources Board
BAU	Business As Usual
CAA	Clean Air Act
CAFE	Corporate Average Fuel Economy
CAR	Climate Action Reserve
CFI	Carbon Financial Instrument
CFI-US	Carbon Financial Instrument (meeting specialized requirement)
CCX	Chicago Climate Exchange
CDM	Clean Development Mechanism
CEC	California Energy Commission
CER	Certified Emission Reduction Credit
CPRS	Carbon Pollution Reduction Scheme
CRT	Climate Reserve Tonne
CSI	California Solar Initiative
DSM	Demand Side Management
EEC	Energy Efficiency Credit
EEPS	Energy Efficiency Portfolio Standards
EEX	European Climate Exchange
EISA	Energy Independence and Security Act of 2007
EPAct	Energy Policy Act of 2005
ERCOT	Electric Reliability Council of Texas
EU ETS	European Union Emission Trading System
EUAs	European Union Emissions Allowances
FAA	Federal Aviation Administration
GHG	Greenhouse Gas
GSE	Ground Support Equipment
GWP	Global Warming Potential

HVAC	Heating, Ventilation, and Air Conditioning
ICE	Intercontinental Exchange
IFM	Improved Forest Management
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
MGGRA	Midwestern Greenhouse Gas Reduction Accord
MII	Majority in Interest
MIRECS	Michigan Renewables Energy Certification System
MRETS	Midwest Renewable Energy Tracking System
mt	Metric Tonnes
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
NAR	North American Renewables Registry
NC-RETS	North Carolina Renewable Tracking System
NEPOOL-GIS	New England Power Pool Generation Information System
NYMEX	New York Mercantile Exchange
NZ ETS	New Zealand Emission Trading System
NZU	New Zealand Unit (emission allowance)
ODS	Ozone Depleting Substance
PFC	Passenger Facility Charge; perfluorocarbon
PJM-GATS	Pennsylvania, Jersey, Maryland Power Pool Generation Attribute System
PPA	Power Purchase Agreement
PV	Photovoltaic
REC	Renewable Energy Credit; Renewable Energy Certificate
RES	Renewable Electricity Standards
RGGI	Regional Greenhouse Gas Initiative
RPS	Renewable Portfolio Standards
UNFCCC	United Nations Framework Convention on Climate Change
VALE	Voluntary Airport Low Emission
VERs	Voluntary Emission Reductions; Verified Emission Reductions
VCS	Verified Carbon Standard
VCU	Verified Carbon Unit
WCI	Western Climate Initiative
WREGIS	Western Renewable Energy Generation System

Carbon Credit

An umbrella term that often encompasses all tradable GHG-based environmental instruments. Generally, a carbon credit refers to a tradable certificate or permit representing the right to emit one metric tonne of carbon dioxide or carbon dioxide equivalent.

Carbon Dioxide (CO_2)

A colorless, odorless, non-poisonous gas that is a normal part of the ambient air. Carbon dioxide is a product of fossil fuel combustion. Although carbon dioxide does not directly impair human health, it is a GHG that traps terrestrial (i.e., infrared) radiation and contributes to the potential for global warming.

Carbon Dioxide Equivalent (CO_2e)

A metric measure used to compare the emissions of the different GHGs based upon their global warming potential (GWP). GHG emissions in the United States are most commonly expressed as "million metric tons of carbon equivalents" (MMTCE). GWPs are used to convert GHGs to carbon dioxide equivalents.

Carbon Financial Instruments (CFIs)

Futures and options contracts issued by the CCX under a voluntary but binding GHG cap-and-trade system. A CFI-US is a special type of CFI with an expiration starting in 2013 that complies with a potential mandatory GHG cap-and-trade program.

Carbon Footprint

A measurement of all GHGs that an individual, company, country, or other entity produces or emits. Entities may look to alternative, more efficient, or more environmentally friendly operating methods to lower their carbon footprint. Carbon footprints can be calculated through GHG inventories in order to measure and monitor carbon reductions. Carbon footprints can also be calculated for consumer products, and generally include the emissions associated with collecting raw materials, manufacturing, shipping, end-use and disposing of the product.

Carbon Market

A market where carbon allowances and offset credits are bought and sold.

Carbon Neutral

Achieving net zero GHG emissions by balancing the amount of carbon emitted with an equivalent amount sequestered or offset. Often this is achieved through obtaining offset credits equal to the number of metric tonnes emitted through a certain GHG emitting activity.

Carbon Pollution Reduction Scheme (CPRS)

The Australian proposed cap-and-trade system that was originally intended to be implemented in 2010. The program has recently faced significant political resistance and the status of implementation is now in doubt.

Carbon Sequestration

The uptake and storage of carbon which can be done naturally or through man-made activities. For example, Natural carbon sequestration could be trees and plants absorbing carbon dioxide, releasing the oxygen and storing the carbon.

	Man-made carbon sequestration is a geoengineering technique for long-term storage of carbon dioxide for the purposes of mitigating global warming.
Carbon Sink	A natural or artificial reservoir that accumulates and stores carbon dioxide.
Certified Emission Reduction Credit (CER)	The credit issued to a developed nation for sponsoring an emission reduction project in a developing nation. One CER is equal to one tonne of CO_2e reduced, avoided, or sequestered.
Chicago Climate Exchange (CCX)	North America's only voluntary, yet legally binding, GHG reduction and trading program for emission sources and offset projects.
Clean Air Act (CAA)	Landmark legislation that was signed into law in the United States in 1970. Many of our existing air pollution laws originate from the CAA. Currently, the Environmental Protection Agency (EPA) is in the process of developing GHG regulations based on provisions contained within the CAA. EPA's authority to regulate GHGs in this manner is the subject of some debate.
Clean Development Mechanism (CDM)	A developed nation with emission reduction commitments sponsors an emission reduction project in a less developed nation in return for a certified emission reduction (CER) credit.
Climate Action Reserve (CAR)	A national offset standards body for the U.S. carbon market. It establishes regulatory quality standards for development, quantification, and verification of GHG emission reduction projects, issuing Climate Reserve Tonnes (CRT) generated from the project and tracking these credits over time.
Climate Change	The term climate change is sometimes used to refer to all forms of climatic inconsistency, but because the Earth's climate is never static, the term is more properly used to imply a significant change from one climatic condition to another. In some cases, climate change has been used synonymously with the term global warming; scientists however, tend to use the term in the wider sense to also include natural changes in climate.
Climate Reserve Tonne (CRT)	The carbon offset credit issued by the Climate Action Reserve.
Compliance Market	A carbon market established by a governmental body, requiring regulated entities to procure and retire allowances or offset credits equivalent to their emissions from the previous year or other designated time period. The governmental body issues a finite number of allowances establishing an emissions cap. Regulated entities may have allowances issued directly to them, or be required to purchase them from a government run auction or by trading with other regulated entities.
Compliance Period	A pre-determined period of time, at the end of which a regulated entity in a cap-and-trade system must retire carbon allowances equal to the number of tonnes of CO_2e they emitted during that designated period of time

Corporate Average Fuel Economy (CAFE)	A federal requirement that automobile manufacturers must achieve certain average fuel economy levels for their entire fleet.
Criteria Air Pollutants	A group of common air pollutants regulated by the EPA on the basis of criteria and information on health and/or environmental effects of pollution. It includes the six most common air pollutants: ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead. Criteria pollutants are the only air pollutants with national air quality standards that have definitions of allowable concentrations of the substances in the air.
Direct Emissions	Emissions from sources within an entity's direct control or boundaries.
Distributed Generation	Electricity generation, usually small in scale, that is produced on-site or close to the entity or entities consuming the power.
Early Action Credits	Credits issued for voluntary reductions of GHGs prior to the commencement of a mandatory or regulatory program.
Electric Generation Sector	Consists of facilities and units that generate electricity. Often in a cap-and-trade system, the electric generation sector is regulated, however the regulated portion of the sector is frequently confined to electricity generating units or facilities combusting fossil fuels.
Emission Intensive	Describes processes or facilities that emit large amounts of GHGs in relation to the given quantity of their product output
Emissions	Releases of gases to the atmosphere (e.g., the release of carbon dioxide during fuel combustion). Emissions can be either intended or unintended releases.
Energy Efficiency Credits (EECs)	See White Tags.
Energy Efficiency Portfolio Standards (EEPS)	A regulatory program requiring utilities to achieve certain levels of improved energy efficiency by their end-use customers. Often EEPS permit trading of white tags between utilities in order to meet compliance requirements.
Energy Intensive	Describes processes or facilities that use or consume large amounts of energy in relation to the given quantity of their product output.
EPA GHG Reporting Rule	A regulatory requirement that large GHG-emitting sources report their GHG emissions on an annual basis to the EPA.
EU ETS GHG Permit	The permit that airlines must obtain in order to operate in the EU after 2012 when airlines become regulated entities.
European Union Emission Trading System (EU ETS)	The world's first binding international trading system for CO_2 emissions. It covers over 11,000 energy-intensive facilities across Europe. The aviation sector will be covered for the first time beginning in 2012.

European Union Emissions Allowances (EUAs) Tradable allowances that regulated entities under the EU ETS must procure and submit for retirement each year equal to the number of tonnes of CO_2e that entity emitted the previous year.

Exchanges An organization which hosts a market where stocks, bonds, options, and commodities are traded. Some exchanges allow participants to trade various forms of carbon credits.

Flexibility Mechanisms Refers to mechanisms used to help countries meet their Kyoto Protocol commitments. The two mechanisms are the Clean Development Mechanism (CDM) and Joint Implementation (JI). They are used and designed to lower the overall cost of achieving emission targets.

Fossil Fuels A general term for buried combustible geologic deposits of organic materials, formed from decayed plants and animals that have been converted to crude oil, coal, natural gas, or heavy oils by exposure to heat and pressure in the Earth's crust over hundreds of millions of years.

Global Warming Potential (GWP) The index used to translate the level of emissions of various gases into a common measure in order to compare the relative radiative forcing of different gases without directly calculating the changes in atmospheric concentrations. It compares the amount of heat trapped by a certain mass of gas to the amount of heat trapped by a similar mass of carbon dioxide. GWPs are calculated as the ratio of the radiative forcing that would result from the emissions of 1 kg of a GHG to that from the emission of 1 kg of carbon dioxide.

Green Branding Activities and initiatives that companies engage in with the goal of having consumers associate that company with environmental conservation, lower carbon footprints, and sustainable business practices.

Greenhouse Gas (GHG) Any gas that absorbs infrared radiation in the atmosphere. GHGs include, but are not limited to, water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrochlorofluorocarbons (HCFCs), ozone (O_3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). "Carbon" is often used interchangeably with GHGs.

Greenhouse Gas Credit See Carbon Credit.

Greenhouse Gas Effect The trapping and build-up of heat in the atmosphere (troposphere) near the Earth's surface. Some of the heat flowing back toward space from the Earth's surface is absorbed by water vapor, carbon dioxide, ozone, and several other gases in the atmosphere and then reradiated back toward the Earth's surface. If the atmospheric concentrations of these GHGs rise, the average temperature of the lower atmosphere will gradually increase.

Hydrofluorocarbons (HFCs) Compounds containing only hydrogen, fluorine, and carbon atoms. They were introduced as alternatives to ozone-depleting substances in serving many industrial, commercial,

	and personal needs. HFCs are emitted as by-products of industrial processes and are also used in manufacturing. They do not significantly deplete the stratospheric ozone layer, but they are powerful GHGs with global warming potentials ranging from 140 (HFC-152a) to 11,700 (HFC-23).
Improved Forest Management (IFM)	Involves forest management activities that maintain or increase carbon stocks on a forested land. Management activities can include thinning diseased or suppressed trees, managing competing brush and short-lived forest species, increasing the stocking of trees on under-stocked areas, amongst others.
Indirect Emissions	Emissions that are the consequence of activities that take place within a facility or organizational boundary, but that occur at sources owned or controlled by another entity.
Industrial Sector	Consists of operations that create a finished, usable product.
Intensity-Based GHG Emission Targets	Emission targets based on the quantity of emissions per unit of gross domestic product.
Intergovernmental Panel on Climate Change (IPCC)	The IPCC was established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change. The IPCC draws upon hundreds of the world's expert scientists as authors and thousands as expert reviewers. Leading experts on climate change and environmental, social, and economic sciences from some 60 nations have helped the IPCC prepare periodic assessments of the scientific underpinnings for understanding global climate change and its consequences. With its capacity for reporting on climate change, its consequences, and the viability of adaptation and mitigation measures, the IPCC is also looked to as the official advisory body to the world's governments on the state of the science of the climate change issue. For example, the IPCC organized the development of internationally accepted methods for conducting national GHG emission inventories
Inventory-Based Programs	A bottom-up approach to emissions accounting in which companies and organizations quantify and report their emissions according to a uniform accounting standard. Participants in a registry agree to measure and report the GHG emissions data from their business activities.
ISO 14064	The most recent addition to the family of the ISO 14000 series of international standards which relate to environmental management and environmental management systems. It provides businesses, governments and other organizations a set of tools and methods to measure, quantify and reduce GHGs.
Joint Implementation (JI)	A country with an emission reduction commitment hosts an emission reduction project to generate emission reduction units (ERUs). The host country essentially gives away the

right to claim these reductions and sells them to another country.

Kyoto Protocol

An international agreement struck by nations attending the Third Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (held in December of 1997 in Kyoto, Japan) to reduce worldwide emissions of GHGs. If ratified and put into force, individual countries have committed to reduce their GHG emissions by a specified amount.

Methane (CH_4)

A hydrocarbon that is a GHG with a global warming potential most recently estimated at 21. Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. The atmospheric concentration of methane has been shown to be increasing at a rate of about 0.6% per year and the concentration of about 1.7 parts per million by volume (ppmv) is more than twice its pre-industrial value. However, the rate of increase of methane in the atmosphere may be stabilizing.

Midwest Greenhouse Gas Reduction Accord (MGGRA)

A regional cap-and-trade program with the Midwestern States of Minnesota, Wisconsin, Illinois, Iowa, Michigan, Kansas and the Canadian Province of Manitoba originally participating. The governors of the participating states, none of whom were governor when the program was agreed to, in 2011 announced that the states would no longer link under regional cap-and-trade and instead would focus on other mechanisms for attracting investment in the states.

New Zealand Emission Trading System (NZ ETS)

The New Zealand GHG cap-and-trade program which was first implemented in 2010.

New Zealand Unit (NZU)

Tradable allowances that regulated entities under the NZ ETS must procure and submit for retirement each year equal to the number of tonnes of CO_2e that entity emitted the previous year.

Nitrous Oxide (N_2O)

A powerful GHG with a global warming potential most recently evaluated at 310. Major sources of nitrous oxide include soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

Offset Credit

A tradable credit representing a unit of CO_2e that is reduced, avoided, or sequestered to compensate for emissions occurring elsewhere.

Offset Protocol

The rules established by offset standard bodies or regulatory bodies which set the criteria for a project to be eligible to earn offset credits.

Offset Standards Body

Organizations that establish standards for developing, quantifying, and verifying GHG reduction projects. Eligible projects

that have successfully completed the offset registration process are eligible to receive offset credits issued from the offset standards body. Offset standards bodies generally have offset credit tracking capabilities which allow buyers and sellers of offset credits to transact with one another.

Ozone-Depleting Substances (ODS)

A family of man-made compounds that includes, but is not limited to, chlorofluorocarbons (CFCs), bromofluorocarbons (halons), methyl chloroform, carbon tetrachloride, methyl bromide, and hydrochlorofluorocarbons (HCFCs). These compounds have been shown to deplete stratospheric ozone, and therefore are typically referred to as ODSs.

Passenger Facility Charge (PFC)

A federal authorization that permits airports to charge passengers for the use of airport infrastructure outside of the contractual use and lease agreement relationship between airport and airlines.

Perfluorocarbons (PFCs)

A group of human-made chemicals composed of carbon and fluorine only. These chemicals (predominantly CF_4 and C_2F_6) were introduced as alternatives, along with hydrofluorocarbons, to ozone-depleting substances. In addition, PFCs are emitted as by-products of industrial processes and are also used in manufacturing. PFCs do not harm the stratospheric ozone layer, but they are powerful GHGs: CF_4 has a global warming potential (GWP) of 6,500 and C_2F_6 has a GWP of 9,200.

Points of Regulation

An entity or class of entities for whom the burden of compliance falls. In a GHG cap-and-trade system the point of regulation can be the entity directly emitting GHGs or an entity who is supplying fossil fuels to an end-use emitter.

Power Purchase Agreement (PPA)

A contract between an entity that generates power and an entity that purchases and consumes electricity.

Pre-Compliance Market

A market for offsets created by participants buying and selling allowances and offsets in anticipation of future regulations. Entities that anticipate being regulated in the future may purchase offset credits to lessen their future exposure under a cap-and-trade program. By definition, in a pre-compliance market, there is no regulation, thus there functionally is little difference between the pre-compliance market and the voluntary market, other than demand drivers. In the voluntary market, demand is often driven by environmental stewardship or green branding; in the pre-compliance market demand is driven by a desire to reduce future risk.

Reforestation

The restocking of existing forests and woodlands which have been depleted. Forests are natural carbon sinks, absorbing carbon dioxide through photosynthesis.

Regional Greenhouse Gas Initiative (RGGI)

A mandatory cap-and-trade program covering GHG emissions from power generators in the Mid-Atlantic and New England. RGGI states include: Connecticut, Delaware, Maine,

	Maryland, Massachusetts, New Hampshire, New Jersey (through 2011), New York, Rhode Island, and Vermont.
Regulated Entity	See Point of Regulation.
Renewable Electricity Standard (RES)	See Renewable Portfolio Standard.
Renewable Energy Certificates (RECs)	Tradable instruments that represent proof that one unit of electricity was generated from a renewable energy resource. Units are usually in MWhs or kWhs.
Renewable Fuel Standard (RFS)	A regulatory program that ensures that transportation fuel sold in the United States contains a minimum volume of renewable fuel. EPA considers the lifecycle GHG impacts of certain renewable fuels to ensure that renewable fuels emit fewer GHGs than the petroleum fuel that it replaces. Producers of renewable fuels are given credits which can be sold to fuel suppliers with compliance requirements.
Renewable Portfolio Standard (RPS)	A regulatory program that requires utilities and other electricity suppliers to ensure that a certain amount of their delivered electricity load is sourced from a renewable energy resource. RPS programs generally permit the use of RECs, which can be traded between generators, utilities, and other market participants.
Sequestration	The process of removing carbon from the atmosphere and depositing it in a reservoir.
Sulfur Hexafluoride (SF_6)	A colorless gas soluble in alcohol and ether, slightly soluble in water. A very powerful GHG used primarily in electrical transmission and distribution systems and as a dielectric in electronics. The global warming potential of SF_6 is 23,900.
Synthetic Gas	A manufactured product chemically similar in most respects to natural gas, resulting from the conversion or reforming of petroleum hydrocarbons. Often, it may be substituted easily for, or interchanged with, pipeline quality natural gas.
The Cap	The number of units of a pollutant that a regulating body sets for which all regulated entities cannot exceed in a given time frame.
The Carbon Disclosure Project	An international organization based in the United Kingdom, which works with shareholders and corporations to disclose the GHG emissions of major corporations.
The Climate Registry	A nonprofit organization formed to create consistent GHG emissions standards and reporting methods for businesses, municipalities, and other organizations.
Trade Exposed	Characterized by firms that compete in a global market that may be competitively disadvantaged by an additional price for GHG emissions for which competitors in non-GHG restrained countries do not have to account.

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